B.E. (Electronics and Instrumentation Engineering)

2022 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University – Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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VISION OF THE DEPARTMENT

To empower graduates with future-ready engineering skills and transform them into intellectually competent and responsible professionals who excel in automation and allied domains, contributing meaningfully to societal and industrial advancement at both national and international reputes

MISSION OF THE DEPARTMENT

- To empower the students with balanced technical education to confront multidisciplinary engineering problems
- To strengthen the relation between academia and industry for their mutual benefits.
- To update the existing infrastructure along with establishing a new one to encourage research and start-up related activities.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Perform effectively in interdisciplinary fields related to Instrumentation engineering, including associated industries, software firms, and academic institutions.

II. Pursue higher studies and research at prestigious institutions in India or abroad.

III. Exhibit social responsibility, teamwork, leadership, and entrepreneurial skills in their professional endeavours.

PROGRAMME OUTCOMES (POs)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

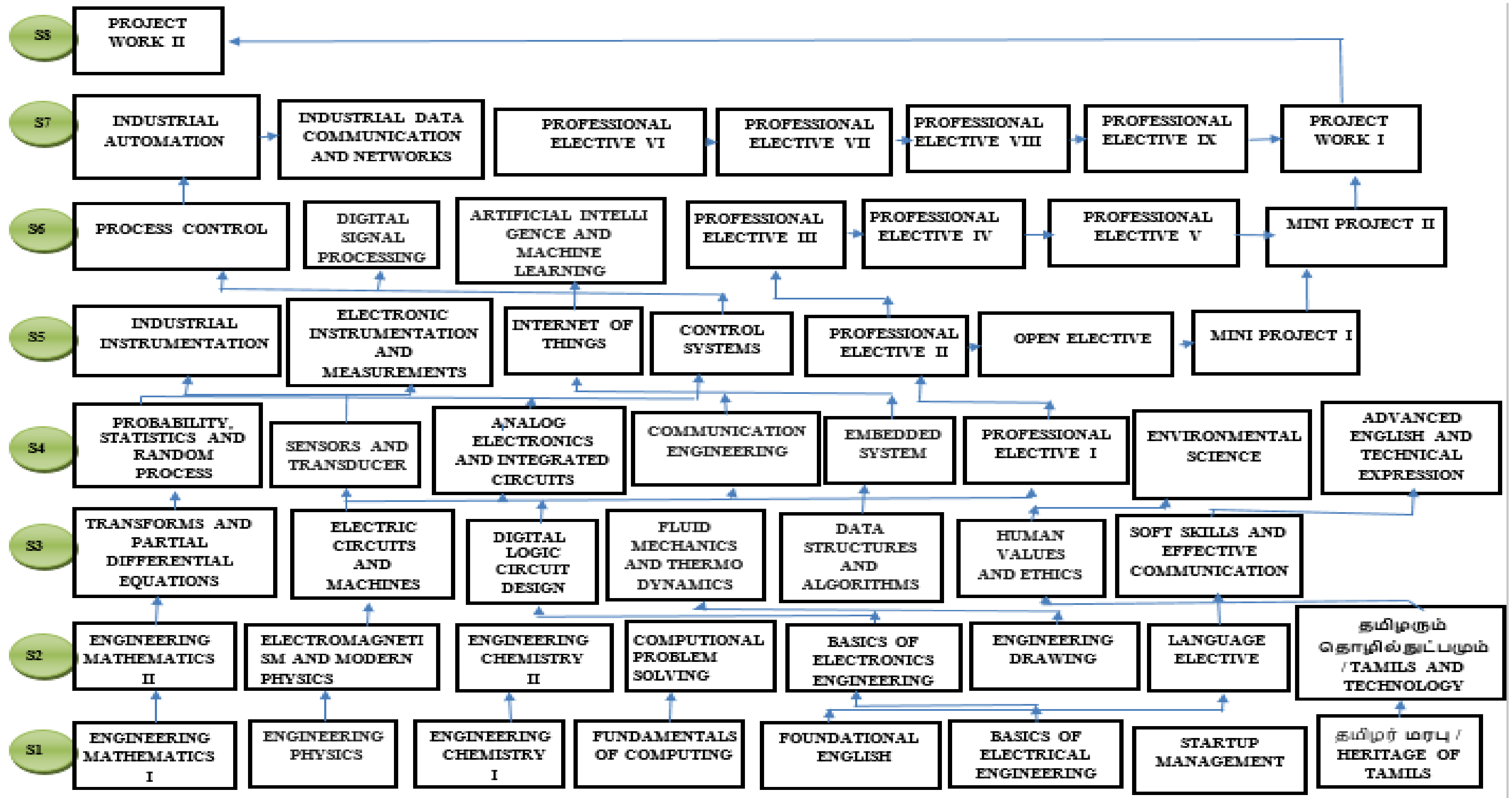
PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Identify suitable sensors and design signal conditioning circuits to measure physical Parameters for industrial applications.
2. Design, develop and realize advanced control schemes in different platforms such as Microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

MAPPING OF PEOs WITH POs & PSOs

PEO(s)	**POs & PSOs**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
I	X	X	X	X	X	X	X			X		X	X	X
II	X	X		X	X	X	X	X	X	X	X	X		
III				X	X		X	X	X	X	X		X	X

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING



DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING – R 2022
Minimum Credits to be Earned : 163

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	3	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	50	50	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	50	50	100	EEC
22HS003	தமிழர் மரபு HERITAGE OF TAMILS#*	1	0	0	1	1	40	60	100	HSS
22EI108	COMPREHENSIVE WORK$	0	0	2	1$	2	100	0	100	EEC
Total		**15**	**1**	**10**	**21**	**26**	**-**	**-**	**-**	**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNETISM AND MODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	50	50	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	50	50	100	HSS
22HS006	தமிழரும் தொழில்நுட்பமும் TAMILS AND TECHNOLOGY^*	1	0	0	1	1	40	60	100	HSS
22HS009	COCURRICULAR OR EXTRACURRICULAR ACTIVITY*	-	-	-	NC	-	100	-	100	HSS
Total		**15**	**1**	**10**	**21**	**26**	**-**	**-**	**-**	**-**

* Applicable for the students admitted during academic year 2024-2025. The lateral entry students have to complete these courses during III and IV semesters.
# Students admitted during academic year 2022-2023 studied this course in semester II.
^ Students admitted during academic year 2022-2023 studied this course in semester III.
$ Applicable only for the students admitted during academic year 2022-2023.

III SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EI301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	3	1	0	4	4	40	60	100	BS
22EI302	ELECTRICAL CIRCUITS AND MACHINES	3	1	0	4	4	40	60	100	ES
22EI303	DIGITAL LOGIC CIRCUIT DESIGN	3	0	2	4	5	50	50	100	PC
22EI304	FLUID MECHANICS AND THERMODYNAMICS	3	0	2	4	5	50	50	100	PC
22EI305	DATA STRUCTURES AND ALGORITHMS	2	0	2	3	4	50	50	100	PC
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	40	100	EEC
Total		**16**	**2**	**8**	**22**	**26**	**-**	**-**	**-**	**-**

IV SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EI401	PROBABILITY, STATISTICS AND RANDOM PROCESS	3	1	0	4	4	40	60	100	BS
22EI402	SENSORS AND TRANSDUCER	3	0	2	4	5	50	50	100	PC
22EI403	ANALOG ELECTRONICS AND INTEGRATED CIRCUITS	3	0	2	4	5	50	50	100	PC
22EI404	COMMUNICATION ENGINEERING	3	0	0	3	3	40	60	100	PC
22EI405	EMBEDDED SYSTEMS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	NC	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	60	40	100	HSS
22HS010	SOCIALLY RELEVANT PROJECT*	-	-	-	NC	-	100	0	100	HSS
Total		**20**	**1**	**8**	**23**	**29**	**-**	**-**	**-**	**-**

* Applicable for the students admitted during academic year 2024-2025.

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EI501	INDUSTRIAL INSTRUMENTATION	3	0	2	4	5	50	50	100	PC
22EI502	ELECTRONIC INSTRUMENTATION AND MEASUREMENTS	3	1	0	4	4	40	60	100	PC
22EI503	INTERNET OF THINGS	3	0	0	3	3	40	60	100	PC
22EI504	CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE
22EI507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
Total		**18**	**2**	**4**	**22**	**24**	**-**	**-**	**-**	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EI601	PROCESS CONTROL	3	0	2	4	5	50	50	100	PC
22EI602	DIGITAL SIGNAL PROCESSING	3	1	0	4	4	40	60	100	PC
22EI603	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
22EI607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**18**	**1**	**6**	**22**	**25**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EI701	INDUSTRIAL AUTOMATION	3	0	2	4	5	50	50	100	PC
22EI702	INDUSTRIAL DATA COMMUNICATION AND NETWORKS*	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
22EI707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**18**	**1**	**6**	**22**	**25**	-	-	-	-

VIII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EI801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total		**0**	**0**	**20**	**10**	**20**	-	-	-	-

* LTPC for this course is 3 0 0 3 for the students admitted during academic year 2022-2023.

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	50	50	100	HSS
22HSH01	HINDI	1	0	2	2	3	50	50	100	HSS
22HSG01	GERMAN	1	0	2	2	3	50	50	100	HSS
22HSJ01	JAPANESE	1	0	2	2	3	50	50	100	HSS
22HSF01	FRENCH	1	0	2	2	3	50	50	100	HSS

ELECTIVES										
PROFESSIONAL ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
VERTICAL I - SENSOR TECHNOLOGIES AND IOT										
22EI001	SMART SENSORS	3	0	0	3	3	40	60	100	PE
22EI002	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22EI003	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22EI004	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EI005	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22EI006	INDUSTRIAL IoT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22EI007	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE
VERTICAL II - AUTOMATION										
22EI008	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE
22EI009	BUILDING AUTOMATION	3	0	0	3	3	40	60	100	PE
22EI010	INTELLIGENT AUTOMATION	3	0	0	3	3	40	60	100	PE
22EI011	SMART MANUFACTURING	3	0	0	3	3	40	60	100	PE
22EI012	AI AND EXPERT SYSTEM FOR AUTOMATION	3	0	0	3	3	40	60	100	PE
22EI013	INTELLIGENT CONTROL	3	0	0	3	3	40	60	100	PE
22EI044	HYDRAULICS AND PNEUMATICS	3	0	0	3	3	40	60	100	PE
VERTICAL III - APPLIED INSTRUMENTATION										
22EI014	ANALYTICAL INSTRUMENTS	3	0	0	3	3	40	60	100	PE
22EI015	VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22EI016	INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES	3	0	0	3	3	40	60	100	PE
22EI017	FIBER OPTICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22EI018	POWER PLANT INSTRUMENTATION AND CONTROL	3	0	0	3	3	40	60	100	PE
22EI019	INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES	3	0	0	3	3	40	60	100	PE
22EI045	SMART AND WIRELESS INSTRUMENTATION	3	0	0	3	3	40	60	100	PE

VERTICAL IV - SEMICONDUCTOR / EMBEDDED										
22EI020	SEMICONDUCTOR MANUFACTURING	3	0	0	3	3	40	60	100	PE
22EI021	AUTOMOTIVE ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EI022	GREEN ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EI023	DIGITAL VLSI	3	0	0	3	3	40	60	100	PE
22EI024	REAL TIME EMBEDDED SYSTEMS	3	0	0	3	3	40	60	100	PE
22EI025	SOLAR PV FUNDAMENTAL AND APPLICATIONS	3	0	0	3	3	40	60	100	PE
22EI046	MICRO ELECTRO MECHANICAL SYSTEM	3	0	0	3	3	40	60	100	PE
VERTICAL V - ADVANCED CONTROL SYSTEMS										
22EI026	PROCESS MODELING AND SIMULATION	3	0	0	3	3	40	60	100	PE
22EI027	SYSTEM IDENTIFICATION	3	0	0	3	3	40	60	100	PE
22EI028	NON LINEAR CONTROL	3	0	0	3	3	40	60	100	PE
22EI029	ADAPTIVE CONTROL	3	0	0	3	3	40	60	100	PE
22EI030	DIGITAL CONTROL SYSTEM	3	0	0	3	3	40	60	100	PE
22EI031	OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN	3	0	0	3	3	40	60	100	PE
22EI047	POWER ELECTRONICS AND DRIVES	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING										
22EI032	APPLIED SOFT COMPUTING	3	0	0	3	3	40	60	100	PE
22EI033	MACHINE LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EI034	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EI035	PYTHON PROGRAMMING FOR AI AND ML	3	0	0	3	3	40	60	100	PE
22EI036	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EI037	NATURAL LANGUAGE PROCESSING	3	0	0	3	3	40	60	100	PE
VERTICAL VII - HEALTHCARE INSTRUMENTATION										
22EI038	BIOMEDICAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22EI039	DIGITAL IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
22EI040	BIO SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
22EI041	HUMAN ASSISTIVE DEVICES	3	0	0	3	3	40	60	100	PE
22EI042	MEDICAL IMAGING SYSTEMS	3	0	0	3	3	40	60	100	PE
22EI043	BRAIN COMPUTER INTERFACE	3	0	0	3	3	40	60	100	PE

HONOURS VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT										
22EIH01	SMART SENSORS	3	0	0	3	3	40	60	100	PE
22EIH02	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22EIH03	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22EIH04	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EIH05	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22EIH06	INDUSTRIAL IoT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22EIH07	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE

MINOR VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT										
22EIM01	SMART SENSORS	3	0	0	3	3	40	60	100	PE
22EIM02	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22EIM03	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22EIM04	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EIM05	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22EIM06	INDUSTRIAL IoT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22EIM07	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE

* Honor and Minor vertical courses offered for the students admitted during academic year 2022-2023 and 2023-2024.

OPEN ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	OE
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE
22OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	OE
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
22OFD04	CEREAL, PULSES AND OILSEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
22OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	OE
22OPH04	BIOPHOTONICS	3	0	0	3	3	40	60	100	OE
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE

22OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE
22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
22OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
22OGE04	NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE
22OBM01	OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES	3	0	0	3	3	40	60	100	OE
22OBM02	AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OBM03	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	OE
22OAG01	RAINWATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OEE01	VALUE ENGINEERING	3	0	0	3	3	40	60	100	OE
22OEE02	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	OE
22OCB01	INTERNATIONAL BUSINESS MANAGEMENT	3	0	0	3	3	40	60	100	OE

ONE CREDIT COURSES										
22EI0XA	ELEMENTS OF INDUSTRIAL AUTOMATION	1	0	0	1	-	100	0	100	EEC
22EI0XB	SMART VISUALISATION OF INDUSTRIAL PARAMETERS	1	0	0	1	-	100	0	100	EEC
22EI0XC	AUTOMOTIVE EMBEDDED SYSTEM	1	0	0	1	-	100	0	100	EEC
22EI0XD	DATA ANALYTICS AND VISUALIZATION	1	0	0	1	-	100	0	100	EEC
22EI0XE	AUTOMOTIVE COMMUNICATION PROTOCOLS	1	0	0	1	-	100	0	100	EEC
22EI0XF	ADVANCED STM32 ARM PROGRAMMING TECHNIQUES	1	0	0	1	-	100	0	100	EEC
22EI0XG	INTELLIGENT SENSOR DESIGN	1	0	0	1	-	100	0	100	EEC

22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on linear, quadratic, power and polynomial, exponential, and multi variable models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Formulate the real-world problems as a quadratic function model
3. Demonstrate the real-world phenomena and data into power and polynomial functions
4. Apply the concept of mathematical modeling of exponential functions in Engineering
5. Develop the identification of multivariable functions in the physical dynamical problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	1	2
2	2	2	-	-	-	-	-	-	-	-	-	-	1	2
3	2	1	-	-	-	-	-	-	-	-	-	-	1	2
4	2	2	-	-	-	-	-	-	-	-	-	-	1	2
5	1	2	-	-	-	-	-	-	-	-	-	-	1	2

UNIT I **9 Hours**

MATHEMATICS MODELING OF LINEAR FUNCTIONS

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylor's series, radius and interval of convergence - Tests of convergence for series of positive terms - Comparison test, Ratio test

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decay - Exponential equations have a variable as an exponent and take the form $y = ab^x$ through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Graphing of functions of two variables - Partial derivatives - Total derivatives - Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
2. B. S. Grewal, Numerical Methods in Engineering & Science: with Programs in C, C++ & MATLAB, Khanna Publishers, 2014.
3. S. C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2020.
4. Thomas and Finney, Calculus and Analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018.

22PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers

Course Outcomes (COs)

1. Apply the work-energy theorem to analyze and optimize mechanical system performance
2. Analyze free and forced mechanical oscillations in vibrational energy systems
3. Analyze the propagation of energy in mechanical systems through transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Apply the concept of energy and entropy to understand the mechanical properties of materials

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	1	-	-	-	-	2	-	-	1	1	2
2	3	2	1	2	-	-	-	-	2	-	-	1	1	1
3	3	2	2	1	-	-	-	-	2	-	-	1	1	1
4	3	2	2	1	-	-	-	-	2	-	-	1	1	1
5	3	2	2	1	-	-	-	-	2	-	-	1	1	1

UNIT I **6 Hours**

CONSERVATION OF ENERGY

Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion - minimization of potential energy - equilibrium - dissipative systems - friction

UNIT II **5 Hours**

VIBRATIONAL ENERGY

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types - Damped oscillations - forced oscillations - natural frequency - resonance

UNIT III **6 Hours**

PROPAGATION OF ENERGY

Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voice - reflection - refraction - beats

UNIT IV **7 Hours**

EXCHANGE OF ENERGY

Energy in transit - heat - Temperature - measurement - specific heat capacity and water - thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes - Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy

UNIT V **6 Hours**

ENERGY IN MATERIALS

Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

EXPERIMENT 1 **5 Hours**

Assess the physical parameters of different materials for engineering applications like radius, thickness and diameter to design the electrical wires, bridges and clothes

EXPERIMENT 2 **5 Hours**

Evaluate the elastic nature of different solid materials for modern industrial applications like shock absorbers of vehicles

EXPERIMENT 3 **5 Hours**

Analyze the photonic behavior of thin materials for advanced optoelectronic applications like adjusting a patients head, chest and neck positions as a medical tool

EXPERIMENT 4 **5 Hours**

Investigate the phonon behavior of poor conductors for thermionic applications like polymer materials and textile materials

EXPERIMENT 5 **5 Hours**

Assess the elongation of different solid materials for industrial applications like buildings, bridges and vehicles

EXPERIMENT 6 **5 Hours**

Measure the compressibility of different liquids for modern industrial applications like navigation, medicine and imaging

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson education, 2017.

3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019.
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017.

22CH103 ENGINEERING CHEMISTRY I **2 0 2 3**

Course Objectives

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllersPO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Apply the principles of nuclear fusion and stellar evolution to explain the processes of hydrogen fusion in stars and the creation of elements
2. Apply the concept of atomic structure of elements in the periodic table to interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyse whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-	1
5	2	1	-	-	-	-	-	-	-	-	-	-	-	1

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

UNIT III **6 Hours**

CHEMICAL BONDING

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**

STATES OF MATTER

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

EXPERIMENT 1 **5 Hours**

Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plants in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

EXPERIMENT 2 **5 Hours**

Investigate the amount of Iron (Fe^{2+}) in a mild steel alloy sample using a spectrophotometer.

EXPERIMENT 3 **4 Hours**

Estimate the amount of chromium present in industry effluent samples and bottled beverages.

EXPERIMENT 4 **5 Hours**

Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

EXPERIMENT 5 **3 Hours**

Assess the acidic nature of effluent water from industries using the conductometric titration method.

EXPERIMENT 6 **4 Hours**

Measure the stain removal efficiency of the prepared soaps from stained clothes.

EXPERIMENT 7 **4 Hours**

Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

Total: 60 Hours

Reference(s)

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, 2nd Edition, Oxford university press, 2020.
2. Peter Atkins, Julio D Paula and James Keeler, Atkins' Physical Chemistry, 12th Edition, Oxford university press, 2019.
3. Gareth Price, Thermodynamics of chemical processes, 2nd Edition, Oxford university press, 2019.

4. D Tabor, Gases, liquids and solids and other states of matter, 3rd Edition, Oxford University press, 2018.
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017.
6. J.D. Lee, Concise inorganic chemistry, 5th edition (Reprint), Blackman Science Ltd, France, Wiley-India, 2016.

22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

Course Objectives

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Infer the hidden languages and inner structures of computer hardware and software through codes and combinations.
2. Interpret the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Infer the fundamentals of operating system and System programs basics.
5. Apply the software development methodologies to various real life scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	3	1	-	-	-	-	-	-	-	-	-	-
3	2	2	2	1	-	-	-	-	-	-	-	-	-	-
4	2	2	2	1	-	-	-	-	-	-	-	-	-	-
5	2	2	2	1	-	-	-	-	-	-	-	-	-	-

UNIT I **8 Hours**

CODES AND COMBINATIONS

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

Communication to computing devices through various input sources - Computational operation - flow, functions and controls - communication to output devices - Basic communication protocol.

UNIT III **11 Hours**

ASSEMBLY LANGUAGE PROGRAMMING

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input - Output - Loops - Simple programs.

UNIT IV **9 Hours**

OPERATING SYSTEM AND APPLICATION GENERATION

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

UNIT V **8 Hours**

SOFTWARE DEVELOPMENT

Phases of application life cycle management - Software Development Methodologies - Web Page development.

Total: 45 Hours

Reference(s)

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliaz, "Little Man Computer Programming: For The Perplexed From The Ground Up", The Internet Technical Bookshop; 1st Edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S. Pressman, "Software Engineering: A Practitioner"s Approach", McGraw Hill International edition, Seventh Edition, 2010.

22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

Course Objectives

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Interpret and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	2	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-
3	-	-	-	-	-	-	-	-	2	3	-	2	-	-
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-
5	-	-	-	-	-	-	-	-	2	3	-	2	-	-

UNIT I **15 Hours**

SELF-EXPRESSION

Self-Introduction - Recreating Interview Scenarios (with a focus on verbal communication) - Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs - Self-Introduction - Recreating interview scenarios - Haptics - Gestures - Proxemics - Facial expressions - Paralinguistics / Vocalics - Body Language - Appearance - Eye Contact – Artefacts Self-Introduction - Powerful openings and closings at the interview - Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH - questions - Prepositions - Listening to Ted talks-Listening for specific information

UNIT II **15 Hours**

CREATIVE EXPRESSION

Descriptive Expression - Picture Description and Blog Writing - Vocabulary - One word substitution - Adjectives - Similes, Metaphors, Imagery & Idioms - Link words - Inclusive language Narrative Expression - Travelogue and Minutes of Meeting -Verbal Analogy -Sequence & Time order words - Jumbled paragraph, sentences, Sequencing - Text & Paragraph completion - Past tense - Using quotation marks

UNIT III **15 Hours**

FORMAL EXPRESSION

Formal Letters and Emails - Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to newspapers - Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail, Conjunctional clause Punctuation - Formal Idioms - Phrases - Articles - Definite & Indefinite - Types of sentences - Modal verbs Precision in comprehension, Summary writing, Selective summary - Reading: Active reading - short paragraphs, excerpts, articles and editorials - Skimming and Scanning Reading comprehension & analysis - Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal - Note-taking-Listening: Listening for data, for specific information, for opinion -Active and passive Listening - Transcription - Paraphrasing and summarizing information-Agreeing & disagreeing - Note-taking-Writing: Summary writing, selective summary, paraphrasing, note-making, opinion pieces - Finding synonyms in the context. Paraphrasing - Sentence Transformation - simple, compound, complex. Sentence substitution - Sentence completion - Interpreting paragraphs

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge IGCSEÃ,Â® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy transfer in electro mechanical conversion

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the behavior of electric charges in different medium using coulombs law.
2. Analyse the electric field due to different charge distributions.
3. Analyse the magnetic field intensity due to long conductor, solenoid, toroid and magnetic dipoles.
4. Analyze the force on conductors due to the moving charges.
5. Apply the energy conversion concepts in electromagnetic fields.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	-	-	2	2	-	-	-	-
2	2	2	2	3	-	-	-	-	2	2	-	-	-	-
3	2	2	1	3	-	-	-	-	2	2	-	-	-	-
4	3	2	1	2	-	-	-	-	2	2	-	-	-	-
5	2	2	-	-	-	-	3	-	2	2	-	-	2	-

UNIT I **5 Hours**

ELECTRIC CHARGE

Properties of charge, additivity of charges, quantization of charge, conservation of charge, Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

UNIT II **7 Hours**

ELECTRIC FIELD

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

UNIT III **7 Hours**

MAGNETIC FIELDS

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

UNIT IV **6 Hours**

FORCE ON CHARGES

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

EXPERIMENT 1 **7 Hours**

Analysis the behaviour of a Fixed Resistor in an Electric Heater

EXPERIMENT 2 **7 Hours**

Construct an Electrical Wiring Layout for a Basic Household Applications

EXPERIMENT 3 **8 Hours**

Analysis the Self and Mutual Induction in a Domestic Fan

EXPERIMENT 4 **8 Hours**

Design a Transistor-Based Electronic Switch

Total: 60 Hours

Reference(s)

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University, 2020.
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill, 2020.
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017.
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited, 2017.

22HS002 STARTUP MANAGEMENT 1 0 2 2

Course Objectives

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering

Programme Outcomes (POs)

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11.Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Generate valid and feasible business ideas
2. Create Business Model Canvas and formulate positioning statement
3. Invent prototypes that fulfills an unmet market need
4. Formulate business strategies and create pitch decks
5. Choose appropriate strategies for commercialization.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	1	2	1	-	1	-	-	-
2	-	-	-	-	-	-	2	2	1	1	2	-	-	-
3	-	-	-	-	-	-	3	3	1	2	2	-	-	-
4	-	-	-	-	-	-	1	3	1	2	2	-	-	-
5	-	-	-	-	-	-	2	3	2	2	2	-	-	-

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

Prototyping: Methods - Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

UNIT V **3 Hours**

COMMERCIALIZATION

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors

EXPERIMENT 1 **1 Hours**

Analysis of various business sectors

EXPERIMENT 2 **2 Hours**

Developing a Design Thinking Output Chart

EXPERIMENT 3 **1 Hours**

Creating Buyer Personas

EXPERIMENT 4 **3 Hours**

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**

Preparation of Business Model Canvas

EXPERIMENT 6 **15 Hours**

Developing Prototypes

EXPERIMENT 7 **2 Hours**

Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**

Preparation of Business Plans

EXPERIMENT 9 **2 Hours**

Preparation of Pitch Decks

Total: 45 Hours

Reference(s)

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012.
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020.
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015.
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021.
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021.

22HS003 HERITAGE OF TAMILS 1 0 0 1

Course Objectives

- Describe the linguistic diversity in India, highlighting Dravidian languages and their features
- Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures
- Examine the role of sports and games in promoting cultural values and community bonding
- Discuss the education and literacy systems during the Sangam Age and their impact.
- Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the concept of language families in India, with a focus on Dravidian languages.
2. Trace the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Identify and differentiate various forms of folk and martial arts in Tamil heritage.
4. Understand the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	2	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-
3	-	-	-	-	-	-	-	-	2	3	-	2	-	-
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-
5	-	-	-	-	-	-	-	-	2	3	-	2	-	-

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

Language Families in India - Dravidian Languages - Tamil as a Classical Language- Classical Literature in Tamil- Secular Nature of Sangam Literature- Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART- SCULPTURE

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India - Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine - Inscriptions & Manuscripts - Print History of Tamil Books.

Total: 15 Hours

Reference(s)

1. Dr. K. K. Pillay, Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

22HS003 - தமிழர் மரபு **1 0 0 1**

பாடத்திட்டத்தின் ந ◌ாக்கம்

1. இந்திய தமொழிக்குடும்பத்Fள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன்மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளர்ச்சிமய இயம்புதல்.
3. சங்ககொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.

கற்றலின் விளைவு

1. இந்திய தமொழிக்குடும்பத்Fள் திரொவிட தமொழிகள் தனித்F இயங்கும் தன்மமமய அதன் சிறப்புகள் வழி அறிதல்.
2. ததொன்றுததொட்டு தமிழர், கமலயில் அமடந்த வளர்ச்சிமய இயம்புதல்.
3. சங்ககொல தமிழரின் கற்றல் திறத்மத இலக்கியங்கள் வழி ஆரொய்தல்.
4. தமிழ் தமொழியின் சிறப்புகமள அதன் பமடப்பிலக்கியங்கள் மூலம் அறிந்F தகொள்ளுதல்.
5. கற்கொலம் தததொடங்கி, இக்கொலம் வமர சிற்பக்கமல அமடந்த வளர்ச்சிமய கண்டுதகொள்ளல் .
6. தமிழர் தம் வொழ்வில் எங்கனம் இயற்மகமய வணங்கி பதொற்றினர் என்பமத திமண பகொட்பொட்டின் வழி ததளிதல்.
7. இந்திய விடுதமல பபொரில் தமிழர் ஆற்றிய பங்கிமன ததரிந்F தகொள்ளுதல்.

அலகு I மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- To impart and analyze the concepts of differential equations to describe in real-world phenomena.
- To provide basic understanding on differential equation models and vector field models.
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering
2. Formulate the real world problems as second order linear differential equations and give solutions for the same
3. Demonstrate the real-world phenomena with magnitude and direction in the form of vector functions
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering
5. Determine complex functions and apply them to formulate problems arising in engineering

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	1	2
2	2	2	-	-	-	-	-	-	-	-	-	-	1	2
3	2	2	-	-	-	-	-	-	-	-	-	-	1	2
4	2	1	-	-	-	-	-	-	-	-	-	-	1	2
5	1	2	-	-	-	-	-	-	-	-	-	-	1	2

UNIT I **9 Hours**

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitz's and method of separation of variables - Cooling/Heating of an object - A falling object - Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

Methods of solving second order linear ordinary differential equations - Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

Vector and scalar functions - Fields - Derivative of a vector function and geometrical interpretation - Velocity and acceleration - Gradient and its properties - Tangent and normal vectors - Directional derivative - Divergence of a vector field - Curl of a vector field - Projectile motion

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

UNIT V **9 Hours**

COMPLEX FUNCTIONS

Basic concepts of Complex numbers - Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow and Electric flow - Mapping of complex functions

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997.
2. Michael Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education, 2018.
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, Thirteenth Edition, Pearson Education, 2013.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley, 2015.
5. J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017.

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS

2 0 2 3

Course Objectives

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research–based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the mechanisms of Coulomb's law and electric potential in various charge system
2. Analyze the magnetic properties of materials and their effects on external magnetic fields
3. Analyze the classification of electromagnetic waves based on frequency and wavelength
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Apply the principles of electron and hole transport to study p-type and n-type semiconductors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	1	-	-	-	-	2	-	-	1	-	-
2	3	2	1	2	-	-	-	-	2	-	-	1	-	-
3	3	2	2	1	-	-	-	-	2	-	-	1	2	1
4	3	2	2	1	-	-	-	-	2	-	-	1	1	-
5	3	2	2	1	-	-	-	-	2	-	-	1	-	-

UNIT I **6 Hours**

ELECTRICITY

Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor- Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

UNIT II **6 Hours**

MAGNETISM

Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

UNIT III **6 Hours**

ELECTROMAGNETIC WAVES AND LIGHT

Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

UNIT IV **6 Hours**

MODERN PHYSICS

Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

EXPERIMENT 1 **5 Hours**

Analysis a I-V characteristics of a solar cell for domestic applications

EXPERIMENT 2 **5 Hours**

Determine the carrier concentration of charge carriers in semiconductors for automotive applications

EXPERIMENT 3 **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 4 **5 Hours**

Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

EXPERIMENT 5 **5 Hours**

Assess the variation of refractive index of glass and water for optical communication

EXPERIMENT 6 **5 Hours**

Evaluate the band gap energy of semiconducting materials for display device applications

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson Education, 2017.
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019.
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018.
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017.

22CH203 ENGINEERING CHEMISTRY II **2 0 2 3**

Course Objectives

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Analyze the working of batteries for the energy storage devices
3. Analyze the specific operating conditions under which corrosion occurs and suggest a method to control corrosion
4. Analyze reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Analyze various types of nuclear transmutation including decay reactions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
3	2	1	-	-	-	-	1	-	-	-	-	-	-	1
4	2	1	-	-	-	-	-	-	-	-	-	-	1	1
5	2	1	-	-	-	-	-	-	-	-	-	-	1	-

UNIT I **6 Hours**

ELECTROCHEMISTRY

Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

UNIT II **6 Hours**

ENERGY STORING DEVICES

Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

UNIT IV **6 Hours**

CATALYSIS

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

UNIT V **6 Hours**

NUCLEAR REACTIONS

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - recent applications of radioactive isotopes.

EXPERIMENT 1 **4 Hours**

Measure industrial effluent water pH and assess water quality against allowed standards

EXPERIMENT 2 **4 Hours**

Iron (Fe^{2+}) in Bhavani River water: Potentiometric Analysis & Pollution Assessment (CPCB Standards)

EXPERIMENT 3 **4 Hours**

Construct a Zn-Cu electrochemical cell and validate the output by connecting the LED light

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

EXPERIMENT 5 **4 Hours**

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application

EXPERIMENT 7 **5 Hours**

Determination of acid-catalyzed hydrolysis kinetics in locally sourced fruit extracts

Total: 60 Hours

Reference(s)

1. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, 2nd Edition, Wiley- VCH, 2017.
2. S. Vairam, Engineering Chemistry, 1st Edition, John Wiley & Sons, 2014.
3. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
4. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.

5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (revised), New Age International Publishers, 2011.
6. E. McCafferty, Introduction to Corrosion Science, 1st Edition, Springer, 2010.

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze a problem and formulate algorithms, pseudocodes and flowcharts.
2. Develop algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Design and apply appropriate data structures for solving computing problems.
4. Compare the various storage devices used in a computer system.
5. Analyze the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	2	-	-	-	-	-	-	-	-	-	-
2	3	3	3	3	-	-	-	-	-	-	-	-	-	-
3	2	2	2	3	-	-	-	-	-	-	-	-	-	-
4	2	2	2	2	-	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

VISUAL PROCESS MODELING

Scenario decomposition - Logical sequencing - Drawing flowchart - Preparation of visual process model.

UNIT II **12 Hours**

ALGORITHMIC DESIGN THINKING

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

UNIT III **12 Hours**

DATA ORGANIZATION

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

UNIT IV **7 Hours**

DATA STORAGE

Flat File and Relational database - Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

UNIT V **8 Hours**

NETWORKING ESSENTIALS

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

Total: 45 Hours

Reference(s)

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Analyze the energy conversion needs and working principle of Special purpose electronic devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1	-	1	-	-	2	1	-	-	1	-
2	3	3	3	2	-	1	-	-	2	1	-	-	2	1
3	3	3	3	2	-	1	-	-	2	1	-	-	2	1
4	3	3	3	2	-	1	-	-	2	1	-	-	2	1
5	3	3	3	1	-	1	-	-	2	1	-	-	2	1

UNIT I **6 Hours**

ENERGY TRANSFER AND SIGNALS

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

UNIT II **8 Hours**

SIGNAL CONDITIONING USING DIODE

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

UNIT III **6 Hours**

SIGNAL CONDITIONING USING TRANSISTOR

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

UNIT V **4 Hours**

DEVICES FOR SPECIAL REQUIREMENTS

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

EXPERIMENT 1 **6 Hours**

Design a voltage multiplier to convert the low voltage from the mains power supply to the high voltage to operate the microwave oven.

EXPERIMENT 2 **6 Hours**

Design and construct regulated DC power supply for Mobile phone charger

EXPERIMENT 3 **6 Hours**

Design and construct an audio amplifier circuit to play the mobile music in a huge speaker.

EXPERIMENT 4 **6 Hours**

Design and construct Switching circuit for the Pump to control over flow and drain condition for overhead tank using PN junction diode.

EXPERIMENT 5 **6 Hours**

Design and construct BJT based circuit to implement two way connection for stair case light application.

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.

3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd Edition, 2018.

22GE005 ENGINEERING DRAWING 1 0 2 2

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	2	-	2	-	-	-	-
2	-	-	-	-	-	-	-	2	-	2	-	-	-	-
3	-	-	-	-	-	-	-	2	-	2	-	-	-	-
4	-	-	-	-	-	-	-	2	-	2	-	-	-	-
5	-	-	-	-	-	-	-	2	-	2	-	-	-	-

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

Definition - standards - drawing tools - drawing sheets - scales - line and its types. Practices on lettering - numbering - dimension of drawings. Construction of conic sections - ellipse - parabola and hyperbola using eccentricity method.

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

Principles of projection - projection of points in four quadrants - first angle projection of straight lines - perpendicular to one plane - parallel and inclined to both planes.

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids - parallel - perpendicular and inclined to one plane using change of position method - inclined to both the planes

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel - perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 45 Hours

Reference(s)

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards - Sp46, 2013.

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objectives

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society.

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Understand the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Explore the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Explore the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Trace the development of scientific terminology and vocabulary in Tamil language.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-

UNIT I **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW) - Graffiti on Potteries.

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House and designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age - Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

Art of Ship Building-Metallurgical studies-Iron industry-Iron smelting,steel-Copper and gold-Coins as source of history-Minting of Coins-Beads making-industries Stone beads -Glass beads-Terracotta beads-Shell beads-bone beats-Archeological evidences-Gem stone types described in Silappathikaram.

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry-Wells designed for cattle use- Agriculture and Agro Processing-Knowledge of Sea-Fisheries-Pearl-Conche diving-Ancient Knowledge of Ocean-Knowledge Specific Society.

UNIT V **3 Hours**

SCIENTIFIC TAMIL

Development of Scientific Tamil-Tamil computing-Digitalization of Tamil Books-Development of Tamil Software-Tamil Virtual Academy-Tamil Digital Library-Online Tamil Dictionaries-Sorkuvai Project.

Total: 15 Hours

Reference(s)

1. Dr. K. K. Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian , Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies
5. Keeladi - Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan , Journey of Civilization Indus to Vaigai, RMRL

22HS006 - தமிழரும் ததாழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் ந ோக்கம்

1. சங்க கொலத்தில் வரலொறு மற்றும் கலொச்சொர ஆவணங்களின் ஒரு வடிவமொக, மட்பொண்டங்கள் மீதொன கிரொஃபிட்டிமய பகுப்பொய்வு தசய்தல்.
2. சிலப்பதிகொரத்தில் கட்டப்பட்ட பமமட கட்டுமொனங்களின் விவரங்கமளயும் அவற்றின் கலொச்சொர முக்கியத்Fவத்மதயும் பகுப்பொய்வு தசய்வதன் மூலம், சங்க கொலத்தில் மொவீரர் கற்களின் கட்டுமொனப் தபொருட்கள் மற்றும் வரலொற்று சூழமல ஆரொய்தல்.
3. சமுத்திரங்கள் பற்றிய பண்மடய அறிமவயும், தமிழ் சமூகத்தில் அதன் தொக்கத்மதயும் ஆரொய்வF ஆகியமவ இப்பொடத்திட்டத்தின் பநொக்கம் ஆகும்.

கற்றலின் விளைவு

1. சங்க கொலத்தில் தநசவுத் ததொழிலின் முக்கியத்Fவத்மதயும் அதன் கலொச்சொர முக்கியத்Fவத்மதயும் புரிந்F தகொள்ளல்.
2. பசொழர் கொல விவசொய மற்றும் நீர்ப்பொசன நமடமுமறகளில் அமணகள், குளங்கள் மற்றும் மதகுகளின் முக்கியத்Fவத்மதப் புரிந்F தகொள்ளல்.
3. சங்க கொலத்தில் வீட்டுப் தபொருட்களில் பயன்படுத்தப்பட்ட கட்டடக்கமல வடிவமமப்புகள் மற்றும் கட்டமமப்பு கட்டுமொன முமறகமள ஆரொய்தல்.
4. பண்மடய தமிழ் கலொச்சொரத்தில், கப்பல் கட்டும் கமல, கடல் வர்த்தகம் மற்றும் பபொக்குவரத்தில் அதன் பங்மக ஆரொய்தல்.
5. தமிழ் தமொழியில் அறிவியல் தசொற்களஞ்சியம் மற்றும் தசொல்லகரொதியின் வளர்ச்சிமயக் கண்டறிதல்.

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

Reference(s)

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22HS009 COCURRICULAR OR
EXTRACURRICULAR ACTIVITIES

Course Objectives

- To develop Interpersonal and Leadership Skills
- To Foster Personal Growth and Time Management
- To enhance Community Engagement and Social Responsibility

Programme Outcomes (POs)

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Build leadership skills and teamwork capabilities by engaging in group activities through organization and participation of events
2. Demonstrate the technical, creative, and interpersonal skills through active participation in technical events.
3. Exhibit balanced academics with diverse cultural, sports, and literary activities, showcasing improved time management and organizational skills.
4. Enhance the social responsibility and community engagement by participating in outreach and extension activities.
5. Gain practical experience and industry insights through field visits, industrial training, and internships.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	3	3	3	-	2	-	-
2	-	-	-	-	-	-	-	3	3	3	-	2	-	-
3	-	-	-	-	-	-	-	3	3	2	-	2	-	-
4	-	-	-	-	-	-	-	2	2	2	-	2	-	-
5	-	-	-	-	-	-	-	3	3	3	-	2	-	-

Every student shall be required to undergo a minimum of 40 hours of Co-curricular / Extracurricular activities organized through society chapters, technical and non-technical Club activities during the II semester, failing which he/she shall not be permitted to appear for the VIII Semester examination. Such students are permitted to appear for the Semester End examinations only after completing the requirements. The attendance of the courses / events shall be maintained on the regular basis by the concerned Co-coordinators and made available in the Office of the Controller of Examinations before the commencement of Semester end examinations of Semester II.

The following co-curricular and extra-curricular activities are conducted on a regular basis and is compulsory for all students. The students' performances are assessed on the basis of their participation and organization of events in voluntary services, performance in technical and nontechnical events, games and sports, performance in literary activities, performance in cultural activities and their participation in District/Regional/State/National and International level events.

Co-Curricular activity

Technical events organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to Workshop, Seminar, Conference, Symposium Technical Contest Competition, Field visit, Industrial Training, and Internships.

Extracurricular activity

Non-Technical Events Organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to NSS Camp, NCC Camp, YRC activity, Yoga, Sports and games, Cultural events, Outreach activity and Extension activity

Total: 40 Hours

22EI301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

3 1 0 4

Course Objectives

- Understand the concepts of Fourier series, Transforms and formation of partial differential equations, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Apply Fourier transform to convert the function in time domain into a sum of sine waves of different frequencies, each of which represents a frequency component.
3. Demonstrate the function in frequency domain whenever the function is defined in time domain through Laplace transforms.
4. Apply the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Exemplify the concepts of partial differential equations and able to apply them to solve real scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-	1
2	2	1	-	-	-	-	-	-	-	-	-	-	-	1
3	2	1	-	-	-	-	-	-	-	-	-	-	-	1
4	2	1	-	-	-	-	-	-	-	-	-	-	-	1
5	2	1	-	-	-	-	-	-	-	-	-	-	-	1

UNIT I **9 Hours**

FOURIER SERIES

Introduction - Periodic functions - Dirichlet's conditions - General Fourier series - Odd and even functions – Parseval's identity - Root mean square value - Harmonic analysis.

UNIT II **9 Hours**

FOURIER TRANSFORM

Fourier integral theorem - Fourier transform and inverse Fourier transform - Sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

UNIT III **9 Hours**

LAPLACE TRANSFORM

Laplace transform: Existence of Laplace transform - Properties of Laplace transform - Laplace transform of periodic function - Inverse Laplace transform: Properties of inverse Laplace transform - Partial fraction method – Convolution - Application of Laplace transform to solve ordinary differential equations with constant coefficients.

UNIT IV **9 Hours**

Z TRANSFORM

Z-Transform - Properties - Inverse Z-transform - Convolution method- Partial fraction method - Solution of difference equations using Z-transform.

UNIT V **9 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of standard types of first order partial differential equations (Clairaut's form, Lagrange linear equation) - Linear partial differential equations of second order with constant coefficients.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil, Advanced Engineering Mathematics, Seventh Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Third Edition, Pearson Education, 2014.
4. Michael D Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education, 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi, 2015.

22EI302 ELECTRICAL CIRCUITS AND MACHINES 3 1 0 4

Course Objectives

- To understand the basic circuits theorems and its simplification techniques
- To determine the operation, characteristics and performance parameters of electrical machines
- To understand operation, characteristics and performance parameters of special machines

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the fundamental laws in electric circuits to compute the electric parameters of direct and alternating quantities.
2. Analyze the resonance frequency, bandwidth, Q factor and RL, RC response time constants for the step and ramp inputs.
3. Select suitable DC Machines by analyzing its characteristics.
4. Analyze the characteristics of three phase induction motor, synchronous motor and transformers.
5. Select suitable special electrical machines for specified applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	-	-	-	-	-	-	-	-	2	1	2
2	3	2	2	-	-	-	-	-	-	-	-	2	1	2
3	3	2	2	-	-	1	-	-	-	-	-	2	-	2
4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
5	3	2	2	-	-	1	-	-	-	-	-	2	-	2

UNIT I **10 Hours**

BASIC CIRCUITS AND SIMPLIFICATION TECHNIQUES

Kirchhoffs Current and Voltage Laws, Independent and dependent sources and their interconnection, power calculations. Mesh, Super mesh, Node and Supernode analysis. Source transformation and source shifting Network Theorems: Superposition, Thevenins, Nortons and Maximum Power Transfer Theorems.
(AC circuit analysis for all the topics of this unit)

UNIT II **8 Hours**

RESONANCE CIRCUITS

Series resonant circuits - Bandwidth of an RLC circuit - Q factor and its effect on bandwidth - Parallel resonance -Simple problems on resonance - Applications of resonance - Introduction - Transient response of RL & RC series circuits with step and ramp inputs - Time Constant - Rise and fall times

UNIT III **9 Hours**

DC MACHINES

Construction of DC Machine, Motoring and generation action, types, EMF equation, Torque equation (Torque-armature current characteristics, Torque-speed characteristics, speed-armature current characteristics), Power flow diagram. Problems on speed, torque & losses. Different methods of speed control, different types of starters for DC shunt motors. Permanent Magnet DC motors, Applications of DC Motors

UNIT IV **10 Hours**

AC MACHINES

Types, Construction, Transformer on No-load (Transformation ratio, EMF equation). Three phase Induction motors, construction and principle of operation, types, slip and torque equation, Torque-slip characteristics, condition for maximum torque & ratios, types of starters. Synchronous motors: Construction, principle of operation, characteristics (V curves) and applications

UNIT V **8 Hours**

SPECIAL MACHINES

Special machines - reluctance motor, repulsion motor, hysteresis motor, stepper motor, servo motor, BLDC, PMSM, Dynamic, regenerative and plugging

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010.
2. R. Muthusubramanian, S. Salivahanan, Basic Electrical and Electronics Engineering, Tata McGraw-Hill Education, Reprint 2012.
3. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Eighth Edition, Tata McGraw Hill, 2013.
4. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017.
5. A.E.Fitzgerald, Charles Kingsley and Stephen D. Umans, Electric Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2014.
6. Stephen J. Chapman, Electric Machinery Fundamentals, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

22EI303 DIGITAL LOGIC CIRCUIT DESIGN 3 0 2 4

Course Objectives

- To acquire the basic knowledge of digital logic levels and digital electronic circuits
- To design and analyze the combinational logic circuits
- To design and analyze the sequential logic circuits

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the various number systems for the simplification of circuits using K-maps.
2. Design the combinational logic circuits for given real time problems.
3. Implement the Sequential logic circuits for given application.
4. Apply the state transition and analyse the design of sequential circuit.
5. Analyze the digital system design using PLD for the interpretation of the logic families.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	-	-	-	-	-	-	1	-	1	-	-
2	3	3	3	-	-	-	-	-	-	1	-	1	1	1
3	3	3	3	-	-	-	-	-	-	1	-	1	1	1
4	3	3	3	-	-	-	-	-	-	1	-	1	1	1
5	3	2	3	-	-	-	-	-	-	1	-	1	1	1

UNIT I **6 Hours**

NUMBER SYSTEMS AND CODES

Introduction to Digital Systems, Review of Number Systems, Representation of signed numbers, Binary Arithmetic using 1"s and 2"s Complements, Codes and their types

UNIT II **10 Hours**

BOOLEAN THEOREMS AND LOGIC REDUCTION

Logic gates, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, AOI, NAND and NOR Implementation - Canonical and Standard Forms of representation, Karnaugh-Map Method

UNIT III **10 Hours**

COMBINATIONAL LOGIC CIRCUITS

Binary adders, Binary Subtractor, Parallel Binary Adders, BCD Adders, Encoder, Decoder, Comparator, Code Convertor, Multiplexers, Demultiplexers, Parity Generator and Checker

UNIT IV **10 Hours**

SEQUENTIAL LOGIC CIRCUITS

Gated Latches & Flip Flops- Level and Edge triggered flip-flops, Flip Flop Conversion. Shift registers, General model of sequential circuits- Mealy/Moore models -Excitation table- State table- State diagram

UNIT V **9 Hours**

COUNTERS, LOGIC FAMILIES AND PLDS

Design of Synchronous & Asynchronous Counters, shift register counters, Hazards in logic circuits, Logic Families, Programmable Logic Devices (PLDs)

EXPERIMENT 1 **2 Hours**

Design and construct combinational circuit to implement two-way connection for staircase light application.

EXPERIMENT 2 **3 Hours**

Design a circuit for Conveyor belt transporting bottled products to packaging, where a deflector plate is activated to deflect bottles into a reject bin if either the weight is not within certain tolerances or there is no cap on the bottle.

EXPERIMENT 3 **5 Hours**

Design a calculator circuit with a seven segment display using encoder, decoder & logic gates.

EXPERIMENT 4 **5 Hours**

Design a Logic Gate-Based Data Routing System: Multiplexer & Demultiplexer Circuit Design

EXPERIMENT 5 **5 Hours**

Design the comparator circuit to compare the number of products/boxes/objects for packaging industries using magnitude comparator

EXPERIMENT 6 **5 Hours**

Design circuit based on direction of data movement and the way data is loaded and unloaded for shopping complex.

EXPERIMENT 7 **5 Hours**

Design and implement automated car parking system using flip fop-counters

Total: 75 Hours

Reference(s)

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
2. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
3. A.Anand Kumar, Fundamentals of Digital Circuits, 4th Edition PHI Learning Private Limited, 2016.

4. Charles H. Roth, Jr., Fundamentals of Logic Design, 2014, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US.
5. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009.

22EI304 FLUID MECHANICS AND THERMODYNAMICS

3 0 2 4

Course Objectives

- To enhance the students' knowledge on fluid statics, kinematics, dynamics and hydraulic pumps
- To study the fundamentals and laws of thermodynamics
- To understand the basic concepts of various thermal applications like Internal Combustion Engines
- To study the working principle and applications of refrigeration and air conditioning systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Interpret the fundamentals properties of fluid systems
2. Classify pumps and explain their working principles
3. Exemplify the basic concepts and laws of thermodynamics
4. Understand the concept of air standard cycles and the working of internal combustion engine
5. Interpret the concept of refrigeration and air conditioning system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	1	-	-	-	-	-	-	-	-	-	-
2	3	1	1	2	-	-	-	-	-	-	-	-	-	-
3	3	1	1	1	-	-	-	-	-	-	-	-	-	-
4	3	1	1	2	-	-	-	-	-	-	-	-	-	-
5	3	1	1	1	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

FLUID PROPERTIES AND KINEMATICS

Fundamental units - mass density - specific weight - viscosity - surface tension- capillarity - compressibility. Streamline - streak line - path line - continuity equation.

UNIT II **9 Hours**

FLUID DYNAMICS AND HYDRAULIC PUMPS

Stream and potential functions - Laminar flow, Turbulent flow - Bernoullis equation - Darcys equation - Pipes in series and parallel - major and minor losses - hydraulic grade line - Classification of pumps - Centrifugal pumps - Reciprocating pumps - Multistage pumps - Specific speed and characteristic curves.

UNIT III **9 Hours**

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

Thermodynamic systems - Boundary - Control volume - System and surroundings - Universe - Properties: State - Process - Cycle - Equilibrium - Work and heat transfer - Point and path functions. First law of thermodynamics for open and closed systems - steady flow energy equations. Second law of thermodynamics - Carnot cycle - Heat engines - Refrigerators and heat pumps.

UNIT IV **9 Hours**

INTERNAL COMBUSTION ENGINES AND AIR STANDARD CYCLES

Internal combustion engines - Classification and Working Principle of four stroke and two stroke engines - spark and compression ignition engines - Applications of Internal Combustion engines. Air standard cycles: Otto, diesel and dual cycles - comparison of efficiency.

UNIT V **9 Hours**

REFRIGERATION AND AIR CONDITIONING

Refrigeration - Basic functional difference between refrigeration and air conditioning - Terminologies of refrigeration - refrigerants - Vapour compression cycle: Pressure - Enthalpy and Temperature- Entropy diagram -Saturation cycles. Vapour absorption. Air-conditioning systems - Terminologies of psychrometry - Simple psychometric processes - summer, winter, window and central air conditioning systems - concept of effective temperature, infiltration, internal heat gains, Human comfort charts.

EXPERIMENT 1 **6 Hours**

Select and propose suitable lubricating oils (2T oil, SAE2040 oil, coconut oil, and neem oil) for two-stroke and four-stroke engine applications.

EXPERIMENT 2 **6 Hours**

Identify and propose a suitable bio oil (coconut oil, sunflower oil, and neem oil) for petrol and diesel engines based on its flash and fire points.

EXPERIMENT 3 **12 Hours**

Measure and display (digitally) the values of water exit velocity, flow rate, volume of water, and pressure in the DAM.

EXPERIMENT 4 **6 Hours**

Analyze the friction factor of various pipes in a distribution of a water supply for domestic applications.

Total: 75 Hours

Reference(s)

1. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2011.
2. R. K. Rajput, A Text book of Fluid Mechanics and Hydraulic Machines, S. Chand and Co. Ltd.
3. B. C. Punmia, Ashok K. Jain and Arun K. Jain, Mechanics of Materials, Laxmi Publications, 2010.
4. Mahesh M Rathore , Thermal Engineering ,Tata McGraw Hill, New Delhi, 2011.
5. Stephen R. Turns, Thermodynamics Concepts and Applications, Cambridge University Press, 2006.
6. Eastop and McConkey, Applied Thermodynamics and Engineering, Pearson Education Ltd., 2009.

22EI305 DATA STRUCTURES AND ALGORITHMS 2 0 2 3

Course Objectives

- To understand the concept of computer programming
- To develop problem solving skills and troubleshooting techniques in electronics
- To develop critical reasoning and problem solving abilities including the use of simulation software for designing and troubleshooting

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Develop abstract data type models and design recursive algorithms.
2. Develop applications by using the concept of Stack, Queues and List.
3. Analyze various sorting and searching algorithms.
4. Apply the Binary Search tree, AVL search tree and Heap tree in writing C++ programs.
5. Apply minimum spanning tree and shortest path algorithms for real time problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	3	3	-	-	-	-	-	-	-	-	-	-
2	-	-	2	2	-	-	-	-	-	-	-	-	-	-
3	2	-	3	2	-	-	-	-	-	-	-	-	-	-
4	-	-	3	2	-	-	-	-	-	-	-	-	-	-
5	3	1	3	3	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

INTRODUCTION

Pseudo code-Abstract Data types-Model for an ADT-ADT Implementations-Algorithm Efficiency-Designing Recursive Algorithms-Recursive Examples.

UNIT II **7 Hours**

LINEAR LIST: STACKS, QUEUES AND LISTS

Arrays : Basic Stack Operation-Stack ADT - Applications of Stack : Queues Operations- Queue ADT -Queue Applications-Linked List-Operations- Basic concepts of Circular and Doubly Linked List.

UNIT III **6 Hours**

SORTING AND SEARCHING

Sorting: Insertion Sort-Selection Sort-Bubble Sort - Quick sort-Heap sort-shell sort-External Sorts-Merge sort-Searching: Sequential search- Binary Search - Hashing-General Idea - Hash Function - Separate Chaining - Open Addressing - Linear Probing.

UNIT IV **5 Hours**

NON LINEAR LIST: TREES

Basic Tree concepts - Binary Trees-Tree Traversals -Expression Trees-Binary Search Trees - AVL Search Trees-Heap concepts-Implementation-Heap Applications: Priority Queue.

UNIT V **6 Hours**

GRAPHS

Definitions - Graph Representations - Adjacency matrix- Adjacency List-Traverse Graph: Depth first Traversal-Breadth first Traversal-Shortest Path Algorithms: Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm- Kruskal's Algorithm.

EXPERIMENT 1 **4 Hours**

Design an MP3 player using singly linked list and its operations

EXPERIMENT 2 **3 Hours**

Design a shopping cart using stack and generate the history of the customer purchase details using queue.

EXPERIMENT 3 **4 Hours**

Implementation of storing a web browser's history

EXPERIMENT 4 **4 Hours**

Interrupt handling in real-time systems

EXPERIMENT 5 **3 Hours**

Design a program to implement a phonebook using sorting

EXPERIMENT 6 **4 Hours**

Design a program to store the possible moves in a chess game using tree data structure.

EXPERIMENT 7 **4 Hours**

Design a postfix calculator (1 3 2 4 * - should calculate 1 - (3 * (2 4))) using stack

EXPERIMENT 8 **4 Hours**

Scanning a hierarchical file system directory structure

Total: 60 Hours

Reference(s)

1. F.RichardGilberg, A.Behrouz. Forouzan, Data Structures, A Pseudocode Approach with C, Thomson, 2007.
2. M. A. Weiss, Data Structures and Algorithm Analysis in C, Pearson Education, 2009.
3. Y.Langsam, M. J.Augenstein and A. M.Tenenbaum, Data Structures using C, Pearson Education, 2004.
4. A. M.AhoHopcroft and J.D. Ullman, Data Structures and Algorithms, Pearson education, 2000.

22HS004 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

Programme Outcomes (POs)

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	3	2	1	-	-	-	-
2	-	-	-	-	-	-	-	3	2	1	-	-	-	-
3	-	-	-	-	-	-	-	3	2	1	-	-	-	-
4	-	-	-	-	-	-	-	3	2	1	-	-	-	-
5	-	-	-	-	-	-	-	3	2	1	-	-	-	-

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics - Openness to change - Self enhancement - Conservation - Self transcendence - Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism- Integrity - Freedom - Justice - Honesty - Truthfulness - Responsibility - Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations - Understanding and living in harmony at various levels of life - Embracing self-love and wellness - Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE

Understanding the harmony in Nature - Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s)

1. Martin, G. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin, 2011.
2. Gupta, N. L. Human Values for The 21St Century. India: Anmol Publications Pvt. Limited, 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing, 2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing, 2023.
5. A Textbook on Professional Ethics and Human Values. India: New Age International (P) Limited, 2007.

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

0 0 2 1

Course Objectives

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats.

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Enhance confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input
2. Effectively communicate in English on formal occasions and proficiency in the use of link words and other discourse markers
3. Provide constructive feedback and file logical complaints
4. Analyse the understanding of oral and written communication in real-world situations.
5. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-

UNIT I **10 Hours**

SELF-EXPRESSION

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken - Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing-Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

UNIT II **10 Hours**

CREATIVE EXPRESSION

JAM, Debate, Review writing, Social media posts Synonyms - Antonyms Cloze test Phrasal verbs Spotting errors Collocation - Commonly mispronounced

UNIT III **10 Hours**

FORMAL EXPRESSION

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

Total: 30 Hours

Reference(s)

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, Mcgraw Hill Education, 2010.
5. Personality Development & Soft Skills, Barun K. Mitra, Oxford University Press, 2012.
6. Business English by Ken Taylor, Orient Blackswan, 2011.

22EI401 PROBABILITY, STATISTICS AND RANDOM PROCESS

3 1 0 4

Course Objectives

- Understand the basic concepts of probability and the distributions with characteristics and also random variables.
- Summarize and apply the design of experimental methodologies of probability for the data analysis using statistical notions.
- The random process represents the mathematical model of the random signals.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
2. Apply the concepts of probability distributions in an appropriate place of science and Engineering.
3. Apply the basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Apply Random Process techniques to the problem of random input signals.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

PROBABILITY AND RANDOM VARIABLES

Axioms of probability - Conditional probability - Total probability - Bayes theorem - Random variables - Probability mass function - Probability density functions - Properties.

UNIT II **9 Hours**

STANDARD DISTRIBUTIONS

Binomial distribution - Poisson distribution - Negative binomial distribution - Exponential distribution - Gamma distribution - Normal distribution and their properties.

UNIT III **9 Hours**

TESTING OF HYPOTHESIS

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on normal distribution for single mean and difference of means - Small sample tests: t-test for mean - F-test - Chi-square test for Goodness of fit and Independence of attributes.

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS AND CONTROL CHART

One way and two way classifications - Completely Randomized Design - Randomized Block Design Latin Square Design. Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts).

UNIT V **9 Hours**

RANDOM PROCESSES

Definition and examples - first order, second order, strictly stationary, wide sense stationary and Ergodic processes - Markov process - Poisson and Normal processes.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Peyton Z Peebles, Probability, Random Variables and Random Signal Principles, Fourth Edition, Tata McGraw Hill Publications, New Delhi, 2010.
2. Richard A Johnson and John Freund, Miller and Freunds Probability Statistics for Engineers, Eighth Edition, Pearson Education, 2015.
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Third Edition, Pearson Education, Delhi, 2002.
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill Publications, Fourth Edition, New Delhi, 2010.

22EI402 SENSORS AND TRANSDUCER 3 0 2 4

Course Objectives

- To understand the concepts of calibration, characteristics and response of transducers
- To impart knowledge in the construction and characteristics of various electrical transducers
- To familiarize about different transducers and sensors

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12.Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers

Course Outcomes (COs)

1. Analyze the errors in measurement and instrumentation systems using static and dynamic characteristics
2. Apply the characteristics of resistive transducer for a given application
3. Analyze the variable inductive transducers for the measurement of displacement and pressure
4. Analyze the capacitive transducers for the given applications
5. Apply the various transduction methods used for field applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	-	-	-	-	-	1	1	2
2	3	2	1	-	-	-	-	-	-	-	-	1	2	2
3	2	2	1	-	-	-	-	-	-	-	-	1	2	2
4	2	2	1	-	-	-	-	-	-	-	-	1	2	2
5	2	2	1	-	-	-	-	-	-	-	-	2	1	2

UNIT I **9 Hours**

CHARACTERISTICS OF INSTRUMENTS

Units and Standards - Static calibration- Classification of errors -Error analysis -Limiting error -Probable error -Static Characteristics-Accuracy, Precision, Resolution, Sensitivity, Linearity, Hysteresis, Range and Span, Drift, Dead Zone- Dynamic characteristics and order of the systems - Transducers classification

UNIT II **9 Hours**

VARIABLE RESISTANCE TRANSDUCERS

Principles of operation - Construction details -Characteristics of resistance transducers -Resistance potentiometers -Strain gauges -Resistance thermometers - Thermistors- Hot wire anemometer -Piezo resistive sensor

UNIT III **9 Hours**

VARIABLE INDUCTANCE TRANSDUCERS

Induction potentiometer -Variable reluctance transducers -Linear Variable Differential Transformer- LVDT Pressure transducer- Rotary Variable Differential Transformer-Eddy current transducers, synchro's and resolvers

UNIT IV **9 Hours**

VARIABLE CAPACITIVE TRANSDUCERS

Variable air gap type - Variable area type - Variable permittivity type - Feedback type capacitance proximity pickup - Capacitor microphone

UNIT V **9 Hours**

OTHER TRANSDUCERS

Piezoelectric transducer- Ultrasonic transducer, magnetostrictive transducer, fiber optic transducers, hall effect transducers, photoelectric transducers, and humidity sensor, Digital transducer.

EXPERIMENT 1 **6 Hours**

Design and construct an electronic pressure gauge with 7 segment LED display for a compressor system

EXPERIMENT 2 **6 Hours**

Design and construct a thermometer to measure the temperature in the water geyser

EXPERIMENT 3 **6 Hours**

Speedometer for two-wheeler application using Hall Effect Transducer

EXPERIMENT 4 **6 Hours**

Design and construct a weighing machine for the kitchen using strain gauge and load cell

EXPERIMENT 5 **6 Hours**

Design and construct a light intensity meter in a closed room using optical transducers

Total: 75 Hours

Reference(s)

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Nineteenth edition Dhanpat Rai & Co (P) Ltd, 2012.
2. H.S.Kalsi, Electronic Instrumentation, Third Edition, Tata McGraw Hill Education Private Limited, 2012.

3. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, 2009.
4. E.O.Doeblin, Measurement Systems: Applications and Design , 6th Edition, Tata McGraw-Hill Book Co., 2012.
5. D. V. S. Murthy,Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
6. J. P. Bentley, Principles of Measurement Systems, 4th Edition, Addison Wesley Longman Ltd., UK, 2015.

22EI403 ANALOG ELECTRONICS AND INTEGRATED CIRCUITS **3 0 2 4**

Course Objectives

- To learn the fundamental concepts behind transistor biasing and to differentiate small signal and large signal circuit models
- To understand the performance metrics of Multistage and Power amplifiers and the working of signal generating and wave shaping circuits
- To analyze the linear and non-linear applications of operational amplifiers.
- To illustrate the operating principle of comparators, Data Converters and various special function ICs.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze different biasing methods for Bipolar Junction Transistors and model different Transistor configurations for BJT
2. Design feedback and power amplifier circuits using Bipolar Junction Transistors
3. Analyze the internal structure of operational amplifiers, its characteristics and applications
4. Design Oscillator and Multivibrator circuits using Bipolar Junction Transistors and operational amplifiers.
5. Design comparator, Data converters and analyze the special function ICs and its application in modern electronic equipment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	-	-	-	1	-	1	2	1
2	3	2	2	-	-	-	-	-	-	1	-	1	2	2
3	3	3	3	-	-	-	-	-	-	1	-	1	3	2
4	3	2	2	-	-	-	-	-	-	1	-	1	3	2
5	2	2	2	-	-	-	-	-	-	1	-	1	3	2

UNIT I **9 Hours**

BIASING

Review of Transistor Biasing- Bias Stability, Bias Compensation - Small Signal CB, CE and CC - Hybrid pi model (High Frequency) - Simplified T Model

UNIT II **9 Hours**

FEEDBACK AMPLIFIERS AND POWER AMPLIFIERS

Cascade and Cascode Amplifier, Difference Amplifier - Feedback amplifiers - Current Series, Voltage Shunt, Current shunt and Voltage Series. Power Amplifiers: Class A, Class B, Class C and Class AB Power Amplifiers, Distortion in Power Amplifiers.

UNIT III **9 Hours**

OP-AMP CHARACTERISTICS

Ideal Op Amp, Operational Amplifier Internal Circuit, DC Characteristics, AC Characteristics, Slew Rate, Inverting and Non inverting Amplifiers, Voltage Follower, Summing Amplifier, Subtractor, Differentiator, Integrator, Instrumentation amplifier, 1st Order LPF, HPF and all-pass filters.

UNIT IV **9 Hours**

WAVEFORM GENERATORS

Barkhausencriterion, Oscillators using BJT: LC, Hartley, Colpitts and Crystal Oscillators, Principles of Op-Amp based Sine Wave Oscillator, RC Phase Shift, Wien Bridge Oscillator, Multivibrators (Op-Amp & 555) - Astable, Monostable

UNIT V **9 Hours**

COMPARATORS, DATA CONVERTERS AND SPECIAL FUNCTION ICS

Open Loop Op Amp Configuration, Comparator, Schmitt trigger, Sample and Hold circuits, Flash ADC, Dual Slope ADC - Binary Weighted Resistor DAC - R-2R Ladder DAC,VCO, Voltage regulator: Fixed and Adjustable

EXPERIMENT 1 8 Hours

Design and implementation of an audio amplifier in home theaters.
Design and implementation of audio volume control using differential amplifiers.

EXPERIMENT 2 8 Hours

Design and implementation of light detector using Operational amplifier.
Design and implementation of Analog arithmetic circuits (Summer/ Subtractor/ Comparator/ Differentiator/ Integrator).

EXPERIMENT 3 **8 Hours**

Design and implementation of ambulance siren circuit using Timer IC.
Design and implementation of Op-Amp based clocks for digital circuits.

EXPERIMENT 4 **6 Hours**

Design and implementation of Analog Temperature Monitor with ADC

Total: 75 Hours

Reference(s)

1. Adel. S. Sedra, Kenneth C. Smith, Microelectronic Circuits Theory and Applications, 7th Edition, Oxford University, 2017.
2. Donald.A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill, 3rd Edition, 2010.
3. David A. Bell, Electronic Devices and Circuits, Oxford Higher Education press, 5th Edition, 2010.
4. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd, 5th Edition, 2018.
5. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, Tata Mc Graw-Hill, 2016.
6. William D.Stanely, Operational Amplifiers with Linear Integrated Circuits. Pearson Education, 4th Edition, 2009.

22EI404 COMMUNICATION ENGINEERING 3 0 0 3

Course Objectives

- To understand the fundamental concepts of communication systems
- To analyze different analog and digital modulation schemes
- To familiarize the basic concept of Optical Fiber Communications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 12: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the concept of amplitude modulation in time and frequency domain
2. Apply angle and phase modulation technique to design FM transmitter and receiver
3. Analyze different types of modulation techniques in digital communication system using time and frequency division multiplexing
4. Apply the appropriate data transmission method for error free transmission
5. Apply wavelength division multiplexing concept to develop fiber optic communication system for telephone and television applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2		-	-	-	-	-	-	-	1	1	-
2	3	2	2		-	-	-	-	-	-	-	1	1	-
3	3	2	2		-	-	-	-	-	-	-	1	1	-
4	2	2	2		-	-	-	-	-	-	-	1	1	-
5	3	2	2		-	-	-	-	-	-	-	1	1	-

UNIT I **9 Hours**

AMPLITUDE MODULATION

Elements of communication systems - Time and frequency domain - Noise and communications - Amplitude modulation - AM Transmitters - AM Receivers.

UNIT II **9 Hours**

ANGLE MODULATION

Angle modulation - Phase modulation - Angle modulation spectrum - FM and Noise - FM stereo - FM measurements - FM Transmitters- FM Receivers - Receiver topologies - FM Demodulators.

UNIT III **9 Hours**

DIGITAL MODULATION

Introduction - Pulse Modulation - Pulse code modulation - Delta Modulation - Line codes - Time division multiplexing.

UNIT IV **9 Hours**

DATA TRANSMISSION

Data coding - Asynchronous Transmission - Synchronous Transmission - Error detection and Correction - Data compression and encryption.

UNIT V **9 Hours**

FIBER OPTIC SYSTEMS

Basic fiber optic systems - repeaters and optical amplifiers - wavelength division multiplexing - submarine cables - SONET - Fiber in local area networks.

Total: 45 Hours

Reference(s)

1. Roy Blake, Electronic Communication Systems, Thomson Delmar Ltd, New York, 2013.
2. Wayne Tomasi, Electronic Communication Systems, Pearson Education Asia Ltd, New Delhi, 2012.
3. Louis Frenzel ,Principles of Electronic Communication Systems by 3rd Edition,TMH publications, 2010.
4. Miller, Modern Electronic Communication, Prentice Hall of India, New Delhi, 2010.
5. William Schweber, Electronic Communication System, Prentice Hall of India Ltd, India, New York, 2010.

22EI405 EMBEDDED SYSTEMS 3 0 2 4

Course Objectives

- To understand the overview of Embedded System Architecture.
- To apply the Embedded C programming concepts in Microcontroller
- To analyse embedded communication protocols

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply 8086 instruction set to implement ALP for performing arithmetic and logic operations.
2. Apply the concept of hardware architecture to select appropriate micro controllers and peripherals for embedded applications.
3. Analyse the special features and architecture of TIVA C series microcontroller.
4. Analyse and program different communication protocols used for Embedded Networking.
5. Design embedded applications by interfacing the OFF-chip peripherals with the microcontroller.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	-	-	-	-	2	-	-	-	1	-
2	3	2	2	2	-	-	-	-	2	-	-	-	1	-
3	3	2	2	2	1	-	-	-	2	-	-	-	2	-
4	3	2	2	2	1	-	-	-	2	-	-	-	2	-
5	3	2	2	2	1	-	-	-	2	-	-	-	2	-

UNIT I **9 Hours**

8086 MICROPROCESSOR

8086 Architecture-8086 Instruction set-8086 Addressing modes- 8086 ALP-Interrupts

UNIT II **9 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

Categories of embedded systems, Specialties of embedded systems, Recent trends in embedded systems, Hardware architecture, Software architecture, Communication software, Process of generation of executable image, Development/testing tools.

UNIT III **9 Hours**

TIVA-C MICROCONTROLLER

TIVA-C Microcontroller Architecture and Its memory map, GPIO Programming, WDT Programming, Interrupt Programming, LPM Programming

UNIT IV **9 Hours**

COMMUNICATION PROTOCOLS

UART, ADC, PWM, Timer, I2C, SPI

UNIT V **9 Hours**

OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING

RTC Interfacing, Bluetooth module interfacing, Analog Sensor interfacing, Motor Interfacing.

EXPERIMENT 1 **4 Hours**

Design a car parking system using 16-bit, 32-bit 8086 microprocessor

EXPERIMENT 2 **4 Hours**

Design a display system for hotel using 8086 microprocessor

EXPERIMENT 3 **5 Hours**

Design a ranking system for students using 8086 microprocessor

EXPERIMENT 4 **5 Hours**

Design a traffic light controller using TIVA-C microcontroller

EXPERIMENT 5 **6 Hours**

Design a printing machine with DC and stepper motor using TIVA-C microcontroller

EXPERIMENT 6 **6 Hours**

Design server room temperature monitoring system using TIVA-C microcontroller

Total: 75 Hours

Reference(s)

1. Ray K &Bhurchandi K.M, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interface", 3rd Edition, McGraw Hill, New Delhi, 2012.
2. Prasad K V K K Embedded Real Time Systems Concepts, Design and Programming Dreamtech press, 2013.
3. Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi TI ARM Peripherals Programming and Interfacing Using C Language Pearson Education, 2014.
4. Jonathan W. Valvano Embedded Systems Introduction to Arm Cortex M Microcontrollers 5th edition ISBN 978-1477508992, 2014.
5. Embedded System Design Using TIVA, TI University Program, Learning Material.

22HS007 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply principles of natural resource management to analyze exploitation cases in forestry, water, minerals, and agricultural sectors, assessing their environmental impacts.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
3. Analyze the existing environmental challenges related to pollution and its management.
4. Analyze the impacts of unsustainable practices, waste management, climate change, and water conservation on environmental sustainability.
5. Analyze the impact of population and human activities on environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	1	-	-	-	-	-	-	-
4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution: (Sewage water treatment by activated sludge and trickling filter process) - noise pollution - thermal pollution. Disaster management - causes - effects - control measures of floods – earthquake.

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development - Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

Total: 30 Hours

Reference(s)

1. Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 4th Edition, New Age International Publishers, New Delhi, 2014.
2. T.G.Jr. Miller and S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014.
3. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.
4. Raven, P.H , Hassenzahl, D.M. and Berg, L.R., Environment, 8th edition. John Wiley & Sons, 2012.
5. Pepper I.L, Gerba C.P. and Brusseau M.L, Environmental and Pollution Science. Academic Press, 2011.

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION

0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- effectively use the language to persuade others
- appreciate the nuances of the language and engage an audience
- use advanced tools of language to improve communicative competence
- prepare for professional demands at the workplace
- give concrete expression to the plans and goals

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Infer the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. Critically evaluate the ethics of persuasive appeals and confidence to influence opinion
4. Analyse a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
5. Create awareness and empathy to emotional signals in communication

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-

UNIT I **15 Hours**

CREATIVE EXPRESSION

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay

UNIT II **15 Hours**

FORMAL EXPRESSION

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

Total: 30 Hours

Reference(s)

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001.
4. Personality Development, Harold R. Wallace & L.Ann Masters, Cengage Learning, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji-Macmillan India Ltd. New Delhi, 1990.
6. English Grammar, Composition and Usage by N. K. Agrawal & F. T. Wood, Macmillan India Ltd., New Delhi.

22HS010 SOCIALLY RELEVANT PROJECT

Course Objectives

- To develop Problem-Solving Skills
- To enhance Research and Analytical Abilities
- To promote Social Responsibility and Ethical Awareness

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Interact with society conduct a field surveys and identify societal issues.
2. Analyze societal problems using engineering principles.
3. Develop plan and provide optimal solutions for social issues using their engineering knowledge and skills.
4. Prepare comprehensive reports on their findings and proposed solutions.
5. Enhance the social responsibility and ethical considerations in engineering.
6. Develop community interaction and managerial skills

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	2	-	-	2	-	-	3	3	3	-	2	-	-
2	-	3	-	-	-	-	-	3	3	3	-	2	-	-
3	-	-	3	-	2	-	-	3	3	2	-	2	-	-
4	-	-	-	-	-	-	-	2	2	2	-	2	-	-
5	-	-	-	-	-	-	-	3	3	3	-	2	-	-
6	-	-	-	-	-	-	-	2	1	2	-	2	-	-

Students have to interact with society, conduct a field survey and identify the issues / problems available in the society. Analyze the issues using engineering knowledge, skills and attitude and provide the optimal solutions to solve the social issues and submit the report.

Total: 40 Hours

22EI501 INDUSTRIAL INSTRUMENTATION 3 0 2 4

Course Objectives

- To understand the different types of level measurements adopted in industrial environment
- To acquire knowledge about the principles of humidity, moisture and viscosity measurements
- To understand and design the99 various types of Pressure, Temperature and flow meters

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Select the appropriate level transducer for the measurement of level in linear and non-linear tank by Analyze the characteristics of electrical type of level meters
2. Examine various methods of Humidity, Moisture, and Viscosity measurement.
3. Analyze the characteristics of pressure measurement transducers and select a suitable method for a specified application.
4. Select the suitable temperature measuring Instruments for a given application based on the temperature ranges.
5. Analyze the characteristics of Mechanical, and electrical type flow meters and select suitable flow meter for a specified flow application.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	-	-	1	1	-	2	1	-	2	2	1
2	3	1	1	-	-	1	1	-	2	1	-	2	2	1
3	3	1	1	-	-	1	1	-	2	1	-	2	2	1
4	3	1	1	-	-	1	1	-	2	1	-	2	2	1
5	3	1	1	-	-	1	1	-	2	1	-	2	2	1

UNIT I **9 Hours**

LEVEL MEASUREMENT

Definition of level - visual indicators - float gauges: different types - level switches - displacer and torque tube - bubbler tube - boiler drum level measurement - hydra step systems - electrical types of level gauges using resistance, capacitance, nuclear radiation, and ultrasonic sensors - measurement of level of solids - paddle wheel type - differential pressure method.

UNIT II **9 Hours**

MEASUREMENT OF HUMIDITY, MOISTURE, AND VISCOSITY

Units and definitions - dry and wet bulb psychrometers - hot wire electrode and hair type hygrometers - dew cell - electrolysis type hygrometer - commercial type dew point meter - moisture terms - moisture measurement in granular materials, solid penetrable materials like wood, web type material - capacitance type - NMR probe for moisture detection - viscosity measurement - Saybolt viscometers - continuous measurement of viscosity - rotameter for viscosity measurement.

UNIT III **9 Hours**

PRESSURE MEASUREMENT

High pressure: Mechanical type- bellows, bourdon, helical, diaphragm or capsule- Dead Weight Piston Gauge - Liquid-Sealed types- Visual Manometers, Float Manometers -D/P transmitter - Electrical types - vacuum gauges: Capacitance Manometers - Pirani, Thermocouple and Thermopile vacuum gauges, hot and cold cathode ionization vacuum gauges - McLeod vacuum calibration gauges.

UNIT IV **9 Hours**

TEMPERATURE MEASUREMENT

Construction - Characteristics - Linearization - Bimetallic thermometers - Industrial RTD construction requirements - signal conditioning - Two-wire, three-wire and four-wire RTDs - Thermistor - Characteristics, measurement methods linearization, thermo well. Thermocouples - laws of intermediate temperatures and metals - types of thermocouple - cold junction compensation thermocouple construction - Optical, Radiation and Infrared Pyrometers

UNIT V **9 Hours**

FLOW METERS

Construction - Characteristics - Selection - Installation - Head type flow meters - Positive displacement flow meters - Inferential meter - Turbine flow meter - Mass Flow Meters - Electromagnetic flow meter - vortex shedding flow meter - target flow meter

EXPERIMENT 1 **5 Hours**

Measurement of water level in overhead tank using Differential pressure transducers

EXPERIMENT 2 **5 Hours**

Humidity and Vacuum measurement in a closed room

EXPERIMENT 3 **5 Hours**

Construct a continuous emission measurement system using the dust measurement device in an Industrial Environment

EXPERIMENT 4 **5 Hours**

Pressure calibration in air compressor using dead weight tester

EXPERIMENT 5 **5 Hours**

Thermocouple Cold junction compensation for heater in a water bath

EXPERIMENT 6 **5 Hours**

Measurement of water flow in water distribution system

Total: 75 Hours

Reference(s)

1. Bela G. Liptak, Process Measurement and Analysis, Volume-I, Instrument Engineers" Handbook, fourth edition, CRC press, USA, 2012.
2. John G. Webster, The Measurement, Instrumentation and Sensors Handbook, CRC and IEEE press, USA, 2017.
3. Tony R. Kuphaldt, Lessons in Industrial Instrumentation, Version 2.33, 2019, open-source textbook. (http://openbookproject.net/books/socratic/sinst/book/)
4. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, Second edition, McGraw-Hill Professional, 2018.
5. Patranabis D, Principal of Industrial Instrumentation, Third edition, Tata McGraw-Hill Education Pvt. Ltd., 2010.

22EI502 ELECTRONIC INSTRUMENTATION AND MEASUREMENTS 3 1 0 4

Course Objectives

- To understand the construction and working of meters used for measurement of current, voltage, power and energy
- To acquire the concepts of the potentiometers and instrument transformers
- To gain knowledge about resistance, inductance and capacitance measuring methods and display/recording devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Select the appropriate measuring instrument to measure electrical parameters.
2. Analyse the principles of watt meters and energy meters to measure power and energy in single and three-phase circuits.
3. Apply the potentiometers and instrument transformers to measure the high voltage and current.
4. Apply appropriate measuring instruments and bridge circuits for the measurement of resistance and impedance in AC and DC systems
5. Apply the appropriate display and recording device to measure the current, voltage, and frequency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	-	-	-	-	-	-	-	-	1	1	-
2	3	1	1	-	-	-	-	-	-	-	-	1	1	-
3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
4	3	2	2	-	-	-	-	-	-	-	-	1	1	-
5	3	2	1	-	-	-	-	-	-	-	-	1	1	-

UNIT I **7 Hours**

MEASUREMENT OF VOLTAGE AND CURRENT

Types of ammeters and voltmeters - Construction and working principle of PMMC Instrument, Moving iron Instrument, Dynamometer type Instrument and Rectifier type Instrument.

UNIT II **9 Hours**

MEASUREMENT OF POWER AND ENERGY

Construction and working principle of Electrodynamometer wattmeter and LPF wattmeter - Phantom loading - Measurement of power in three phase circuits - three phase wattmeters - Construction and working principle of single phase energy meter - Calibration of wattmeter, energy meter.

UNIT III **9 Hours**

POTENTIOMETERS AND INSTRUMENT TRANSFORMERS

Potentiometers: Construction and working principle of Crompton"s potentiometer, Precision potentiometer, polar and Co-ordinate types - Applications. Instruments Transformers: Construction and working principle of Current transformers and Potential Transformers- Clamp meters

UNIT IV **12 Hours**

MEASUREMENT OF RESISTANCE AND IMPEDANCE

DC Bridges- Wheatstone bridge, Kelvin double bridge and Direct deflection methods - AC bridges - Maxwell, Wien's bridge, Hay's bridge and Anderson's bridge- Maxwell's inductance-capacitance bridge - De Sauty's bridge, and Schering bridge - Measurement of relative permittivity - Heaviside mutual inductance bridge - Megger.

UNIT V **8 Hours**

DISPLAY AND RECORDING DEVICES

Cathode ray oscilloscope - Time base generator - Basic CRO circuits - measurement of voltage, current, frequency and phase angle - Digital storage oscilloscope - Seven segment and dot matrix displays - Magnetic tape and disc recorders/reproduces - Protection and grounding circuits.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Company, 2014.
2. Ernest O.Doebelin, Dhanesh N Manik, Measurement systems, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2011.
3. J. B. Gupta, A Course in Electronic and Electrical Measurements and Instrumentation, S.K.Kataria & Sons, Delhi, 2013.
4. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill company, New Delhi, 2010.
5. Reissland,U. Martin, Electrical Measurements: Fundamentals, Concepts, Applications, New Age International (P) Ltd., 2012.
6. E. W. Golding and F. C. Widdis, Electrical Measurements & Measuring Instruments, Reem Publications (P) Ltd, 2011.

22EI503 INTERNET OF THINGS 3 0 0 3

Course Objectives

- To impart knowledge in the Internet of Things (IoT)
- To understand the concept of interfacing smart sensors/actuators with internet connectivity
- To illustrate the various protocol standards deployed in the Internet of Things (IoT) domain

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyse the characteristics and various design levels in internet of things.
2. Attribute the network design in IoT deployment.
3. Apply the IoT design principles on connected devices, domains and various protocol standards
4. Design the IoT ad-hoc network using protocol.
5. Analyse the working challenges of IoT on various domain-specific applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	1									1	
2	2	1	1	1									1	
3	2	2	2	2									2	
4	2	2	2	2									1	
5	2	2	2	2									2	

UNIT I **9 Hours**

INTRODUCTION TO INTERNET OF THINGS

Introduction to Internet of Things: Overview of Internet of Things, defining characteristics, connected things, functional blocks, architectural models, communicating APIs, Comparing Internet of Things and Machine to Machine (M2M) connectivity, Differences between IoT and M2M

UNIT II **9 Hours**

DESIGN OF INTERNET OF THINGS

Design of Internet of Things: Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and Deployments, Introduction to Physical Devices and Endpoints.

UNIT III **9 Hours**

DESIGNING CONNECTED COMPONENTS

Designing Connected Devices: Basic Design Principles, Embedded Computing basics, Prototyping, Embedded prototyping, Sensors, Actuators, Beagle Bone Black, Development Options, Online Prototyping tools and components, APIs, Moving to the market needs, SoC WiFi Controller with Cloud connectivity

UNIT IV **9 Hours**

VARIOUS PROTOCOL STANDARDS AS ENABLERS OF IOT

Various Protocol Standards as enablers of IoT: Overview of Internet communications - TCP/IP and UDP, Static and Dynamic Assignment, IP Address, IPv4 and IPv6, Wireless Communication Standards for IoT - WiFi Connectivity include Servers - Security Protocols for IoT Networks.

UNIT V **9 Hours**

DOMAIN-SPECIFIC IOT AND THEIR CHALLENGES

Domain Specific IOT and their challenges: Illustrated Domains - Home Automation, Smart Cities, Environment, Energy, Retail, Logistics, Health and Life Style, Industrial IoT

Total: 45 Hours

Reference(s)

1. Samuel Greengard, The Internet of Things (Essential Knowledge), MIT Press, 2015.
2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, 2015.
3. Arshdeep Bagha & Vijay Madisetti, Internet of Things - A Hands-On Approach,VPT, 2014.

22EI504 CONTROL SYSTEMS 3 1 0 4

Course Objectives

- To understand the basic concepts of open loop and closed loop control systems.
- To analyze the given system in time domain.
- To understand the concept of frequency domain analysis
- To understand the concept of stability of system
- To design the compensator for different control systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
2. Analyze the performance of first and second order system and compute the steady state error using different test signals.
3. Analyze the given system using frequency response domain specifications.
4. Investigate the stability of a given system using Routh Hurwitz criterion & Root Locus technique and Design compensator using time domain analysis
5. Develop a mathematical model of a physical system using state variable techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	2	-	-	-	-	-	-	-	1	-	1
2	3	2	-	2	1	-	-	-	-	-	-	1	-	3
3	3	2	-	2	1	-	-	-	-	-	-	1	-	1
4	3	2	2	2	1	-	-	-	-	-	-	1	-	3
5	3	2	-	2	-	-	-	-	-	-	-	1	-	1

UNIT I **9 Hours**

MATHEMATICAL MODEL OF PHYSICAL SYSTEMS

Basic elements in control systems Open and closed loop systems with examples Mathematical representation of systems Transfer function mechanical and electrical systems, Electrical analogy of mechanical systems Block diagram reduction techniques Signal flow graphs.

UNIT II **9 Hours**

TIME DOMAIN ANALYSIS

Standard test signals Time response of first order and second order systems for unit step test signals Time domain Specifications-Steady state response Static error constants steady state error Effects of proportional derivative, proportional integral systems.

UNIT III **8 Hours**

FREQUENCY DOMAIN ANALYSIS

Frequency response of systems Frequency domain specifications Correlation between frequency domain and time domain specifications frequency domain analysis using Bode plot, Polar plot.

UNIT IV **10 Hours**

STABILITY ANALYSIS OF CONTROL SYSTEM

Concepts of stability Necessary conditions for Stability Characteristics equation Location of roots in S plane for stability Routh Hurwitz criterion Nyquist stability criterion Root Locus technique- Relative Stability

UNIT V **9 Hours**

COMPENSATOR DESIGN AND STATE VARIABLE ANALYSIS

Compensators: Deign of Lag compensator Lead compensator Lag-lead compensator (using Bode plot) Concept of state, state variables, and state model, Controllability and observability tests.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, 2011.
2. M Gopal, Control Systems Principles and Design, Tata McGraw hill, New Delhi, 2012.
3. K.Ogatta, Modern Control Engineering, Pearson Education, New Delhi, 2015.
4. Benjamin C. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd., 2014.
5. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2003.

22EI507 MINI PROJECT I — 0 0 2 1

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2	-	-	2	2	2	-	-	1	1
2	1	2	1	1	2	-	-	2	2	2	-	-	1	1
3	1	2	1	1	2	-	-	2	2	2	2	-	1	1
4	1	2	1	1	2	-	-	2	2	2	2	-	1	1
5	1	2	-	-	2	-	-	2	2	2	-	-	1	1

22EI601 PROCESS CONTROL 3 0 2 4

Course Objectives

- To obtain the mathematical models for first order and higher order real-time systems and also the characteristics of various controller modes
- To get adequate knowledge about the various controller tuning and multi loop control
- To understand the construction, characteristics and application of different types of actuators and unit operations for real time applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Develop mathematical models and analyze the dynamics of first-order and two-tank systems, to design effective control strategies in both continuous and batch industrial applications.
2. Analyze control systems using basic and composite control actions to evaluate their step responses, and implement electronic controllers to achieve effective process regulation.
3. Analyze the various control schemes and obtain optimum controller settings using tuning methods
4. Analyze and select appropriate control valves, actuators, and positioners, including smart positioners, based on valve characteristics, sizing criteria, and considerations for cavitation and flashing, to ensure efficient process control
5. Apply complex control schemes for various applications and develop the P&ID structure for level and flow control loops

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	-	2	-	-	-	1	1	-	1	-	2
2	3	3	2	-	2	-	-	-	1	1	-	1	-	2
3	3	3	2	-	2	-	-	-	1	1	-	1	-	3
4	3	3	2	-	2	-	-	-	1	1	-	1	2	2
5	3	3	2	-	2	-	-	-	1	1	-	1	-	3

UNIT I **9 Hours**

INTRODUCTION

Need for process control-continuous and batch process - mathematical model of first order process using mass and energy balance equations - two tank interacting and non-interacting process - servo and regulator operation - degrees of freedom - self-regulation.

UNIT II **10 Hours**

CONTROLLER CHARACTERISTICS

Basic control actions - characteristics and step responses of ON-OFF, multi-position, floating-control mode, proportional, integral and derivative control modes - composite control modes: P+I, P+D and P+I+D control modes - step response of composite control modes - bumpless transfer - Proportional and derivative kick, reset windup - Electronic controllers to realize various control actions -Guidelines for selection of controller mode.

UNIT III **8 Hours**

TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL

Optimum controller settings- Evaluation criteria -IAE, ISE and ITAE - quarter decay ratio - Tuning of controllers by process reaction curve method - damped oscillation method - Ziegler-Nichols tuning - Feed forward control - ratio control - cascade control - averaging control - inferential and split range control.

UNIT IV **9 Hours**

FINAL CONTROL ELEMENT

I/P and P/I converters - pneumatic and electric actuators - valve positioner - smart positioned-control valve - characteristics of control valves - type of valves: globe, butterfly, diaphragm, ball valves - control valve sizing - cavitation and flashing in control valves - Selection of control valves.

UNIT V **9 Hours**

SELECTED UNIT OPERATIONS

Binary distillation column - reflux control - Case study: control of heat exchange, evaporator control, reactor control, drum level control and combustion control. Piping and Instrumentation Diagram (P&ID) symbols - P&ID for level and flow control loops.

EXPERIMENT 1 **5 Hours**

Open loop response of interacting and non-interacting level process.

EXPERIMENT 2 **5 Hours**

Analyse the response of different types of control valves.

EXPERIMENT 3 **5 Hours**

Tuning of PID controller for first and second order system.

EXPERIMENT 4 **5 Hours**

Closed loop Cascade control of level and flow process with and without transportation lag.

EXPERIMENT 5 **5 Hours**

Closed loop control of temperature process station.

EXPERIMENT 6 **5 Hours**

Closed loop control of pressure process station.

Total: 75 Hours

Reference(s)

1. Curtis D. Johnson, Process Control Instrumentation technology, Pearson new international edition 2013.
2. George Stephanopoulos, Chemical Process Control, PHI learning Pvt. Ltd., New Delhi, 2012.

3. D.R. Coughanowr, Steven E LeBlanc, Process Systems Analysis and Control, McGraw Hill,Singapore, 3rd Edition, 2009.
4. B. Wayne Bequette, Process Control: modelling, Design, and simulation, PHI learning Pvt Ltd., New Delhi, 2010.
5. Jonathan Love Process Automation Handbook: A Guide to Theory and Practice, Springer, 2010.
6. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 30th reprint 2010.

22EI602 DIGITAL SIGNAL PROCESSING 3 1 0 4

Course Objectives

- To understand the signals and systems and their mathematical representation in time/frequency domain.
- To analyze the discrete time systems using Z-transform and Inverse Z-transform.
- To implement the discrete time systems in Discrete Fourier Transform using Fast Fourier Transform algorithm
- To design FIR filters with its response and obtaining its realization structure.
- To design IIR filters with its response and obtaining its realization structure.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyse mathematical functions, categorize signals and systems, and implement sampling and quantization techniques for converting analog signals to digital format.
2. Evaluate the stability of discrete-time systems using the Z-transform and use the discrete-time Fourier transform to convert signals from the time domain to the frequency domain.
3. Apply the discrete Fourier transform and fast Fourier transform to analyze discrete-time systems, converting signals from the time domain to the frequency domain.
4. Design and analyze FIR filters, evaluate their responses, and develop their realization structures.
5. Design and analyze IIR filters, assess their responses, and develop their realization structures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	1	-	-	-	-	-	-	-	-	2	2
2	3	3	1	1	-	-	-	-	-	-	-	-	-	2
3	3	3	1	1	-	-	-	-	-	-	-	-	-	2
4	3	2	3	1	-	-	-	-	-	-	-	-	2	2
5	3	2	3	1	-	-	-	-	-	-	-	-	2	2

UNIT I **10 Hours**

SIGNALS AND SYSTEMS

Classification of Systems: Continuous, Discrete, Linear, Causal, Stability, Dynamic, Recursive, Time Variance Systems; Classification of Signals: Continuous and Discrete, Energy and Power; Mathematical representation of Signals; Mathematical Operation of Signals; Sampling Theorem, Sampling techniques, Quantization, Quantization error, Nyquist rate, Aliasing effect.

UNIT II **9 Hours**

DISCRETE TIME SYSTEM ANALYSIS

Z-transform and its properties, Inverse Z-transforms; Difference equation - Solution by Z-transform, Application to Discrete Systems - Stability analysis, Frequency response - Convolution - Discrete Time Fourier transform, Magnitude and Phase representation.

UNIT III **8 Hours**

DISCRETE FOURIER TRANSFORM

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm - DIT & DIF using radix 2 FFT - Butterfly structure.

UNIT IV **10 Hours**

DESIGN OF FIR DIGITAL FILTERS

Finite Impulse Response (FIR) design: Amplitude and phase responses of FIR filter - Linear phase characteristics - Need and choice of windows - Windowing Techniques: Rectangular, Hamming and Hanning; Realization of FIR filter using direct, Cascade and lattice structures.

UNIT V **8 Hours**

DESIGN OF IIR DIGITAL FILTERS

Realization of IIR filters using direct, cascade and parallel forms, Design of analogue Butterworth and Chebyshev Filters. Design of IIR digital filters using impulse invariance technique, bilinear transform Realization of IIR filters using direct, cascade and parallel forms.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, PHI, Fourth Edition, 2014.
2. S.K. Mitra, 'Digital Signal Processing - A Computer Based Approach', McGraw Hill Edu, 2011.
3. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015.
4. Richard G. Lyons, D. Lee Fugal, The Essential Guide to Digital Signal Processing, Pearson Education, 3rd Edition, 2014.
5. S. Salivahanan, A.Vallavaraj, Gnanapriya, Digital Signal Processing, McGraw-Hill, 2nd Edition, 2011.
6. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Discrete - Time Signal Processing, Pearson Education, New Delhi, 2013.

22EI603 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

3 0 2 4

Course Objectives

- To understand the problem solving intelligent agents and searching techniques.
- To Impart domain knowledge in different machine learning method.
- To realize the different applications in AI

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the concepts of intelligent agents and its structure
2. Apply appropriate search algorithms for solving given AI problems.
3. Differentiate learning strategies, regression and classification in Artificial Intelligence Systems.
4. Analyze the basic concepts of reinforcement learning and find solutions
5. Apply the machine learning techniques in AI applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	-	-	2	-	-	-	-	-	-	1	2
2	2	2	1	2	-	-	-	-	-	-	-	-	2	2
3	2	2	2	3	-	-	-	-	-	-	-	-	2	2
4	3	2	2	1	-	-	2	-	-	-	-	-	1	2
5	-	2	2	-	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

INTELLIGENT AGENTS

Introduction to AI, Agents and Environments, Concept of rationality, Nature of environments, Structure of agents, problem solving agents, search algorithms, uninformed search strategies

UNIT II **9 Hours**

PROBLEM SOLVING

Heuristic search strategies, Heuristic functions, Local search and optimization problems, Local search in continuous space Online search agents and unknown environments, optimal Decisions in games, Constraint satisfaction problems (CSP).

UNIT III **9 Hours**

MACHINE LEARNING METHODS

Forms of learning, Supervised learning, Learning decision trees, Evaluation and choosing the best hypothesis, Theory of Learning, Regression and classification with linear models, Artificial Neural network, Non parametric model, Support vector machine, Ensemble learning.

UNIT IV **9 Hours**

REINFORCEMENT LEARNING

Introduction to Reinforcement Learning, Active and Passive Reinforcement Learning, Generalization in reinforcement learning, Policy Search, Applications of Reinforcement Learning.

UNIT V **9 Hours**

AI APPLICATIONS

Natural Language Processing Language Models, Text Classification, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition, Robotics, Robotic Hardware and Robotic perception.

EXPERIMENT 1 **4 Hours**

Develop PEAS descriptions for given AI Experiment.

EXPERIMENT 2 **5 Hours**

Implement basic search strategies for selected AI applications.

EXPERIMENT 3 **5 Hours**

Implement a classifier for the sales data.

EXPERIMENT 4 **5 Hours**

Develop a predictive model for predicting house prices.

EXPERIMENT 5 **5 Hours**

Apply reinforcement learning and develop a game of your own.

EXPERIMENT 6 **6 Hours**

Apply Natural language processing to develop filters for spam and non-spam mails.

Total: 75 Hours

Reference(s)

1. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence: A Modern Approach, Prentice Hall, Fourth Edition, 2020.
2. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020.
3. T.M. Mitchell, Machine Learning, McGraw-Hill 2017.
4. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Third Edition 2014.
5. Stephen Marsland, Machine Learning An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

22EI607 MINI PROJECT II **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11.Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Formulate a real-world problem, identify the requirement, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2	-	-	2	2	2	-	-	1	1
2	1	2	1	1	2	-	-	2	2	2	-	-	1	1
3	1	2	1	1	2	-	-	2	2	2	2	-	1	1
4	1	2	1	1	2	-	-	2	2	2	2	-	1	1
5	1	2	-	-	2	-	-	2	2	2	-	-	1	1

22EI701 INDUSTRIAL AUTOMATION 3 0 2 4

Course Objectives

- To understand the fundamentals of Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS)
- To program and configure the advanced controller for a given application
- To familiarize the functions of Human Machine Interface

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Select the appropriate components for executing logical programming in PLC.
2. Design PLC, PAC and SCADA programming for given real time applications.
3. Compare the Hybrid, Central Computers and Distributed architectures of DCS.
4. Implement various hardware interfacing methods with DCS for real time applications.
5. Apply various hardware interfacing methods with HMI for real time applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	3	-	-	-	1	1	-	2	1	3
2	3	2	2	-	3	-	-	-	1	1	-	2	-	3
3	2	-	-	-	3	-	-	-	1	1	-	2	-	3
4	3	-	-	-	3	-	-	-	1	1	-	2	-	3
5	3	-	2	-	3	-	-	-	1	1	-	2	-	3

UNIT I 10 Hours

PROGRAMMABLE LOGIC CONTROLLER

Evolution of PLCs- Components of PLC - Architecture of PLC - Discrete and analog I/O modules - Programming languages - Ladder diagram - Function block diagram (FBD) - Programming timers and Counters- Instructions in PLC - Program control instructions, math instructions, data manipulation Instructions, sequencer and shift register instructions.

UNIT II **9 Hours**

PLC PAC SCADA AND ITS APPLICATIONS

Case studies in PLC: Automatic Traffic Control, Automatic bottle filling System, Automatic level and flow control- Introduction to SCADA - components of SCADA - features of SCADA- Introduction to PAC- Features of PAC

UNIT III **8 Hours**

DISTRIBUTED CONTROL SYSTEM

DCS - Various Architectures: Hybrid, Central Computers, Distributed architectures - Comparison - Local control unit - Architectures - Process interfacing issues- Redundant Controller Designs - Remote I/O's - Process Input/ Output Design Issues.

UNIT IV **9 Hours**

INTERFACES IN DCS

Operator interfaces - Low level and high level operator interfaces - Displays - Engineering interfaces - Low level and high level engineering interfaces - Factors to be considered in selecting DCS - Case studies in DCS- Control of Mixing unit in Cement industries- Automatic elevator control.

UNIT V **9 Hours**

HUMAN MACHINE INTERFACE

Human Machine Interface function - Data Handling with HMI- Command line interface- Interface design- Configuration and interfacing with PLC and PC- Communication standards, Ethernet, profibus, RS485

EXPERIMENT 1 **5 Hours**

Control of Level and flow using PLC

EXPERIMENT 2 **5 Hours**

Control of automatic bottle filling system using PLC

EXPERIMENT 3 **5 Hours**

Control of Traffic light system using PLC (Sequence output instruction).

EXPERIMENT 4 **5 Hours**

Control of Pressure and Flow process using DCS

EXPERIMENT 5 **5 Hours**

Interfacing of AC and DC motors using HMI

EXPERIMENT 6 **5 Hours**

Interfacing of Variable Frequency Drive with PLC

Total: 75 Hours

Reference(s)

1. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third Edition, 2010.
3. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, 2012.

22EI702 INDUSTRIAL DATA COMMUNICATION AND NETWORKS **3 1 0 4**

Course Objectives

- To understand the concept of Data communication and networks and its standards.
- To explain the function of various protocols
- To explore the network security.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the basics of Data communications to model the networks.
2. Analyze the significance of different industrial networks.
3. Analyze the architecture of HART and Field bus protocol for the industrial applications.
4. Compare Modbus and Profibus protocols.
5. Analyze the industrial network threats and propose appropriate solution.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	1	-	2
2	3	2	1	-	-	-	-	-	-	-	-	1	-	2
3	3	2	1	-	-	-	-	-	-	-	-	1	-	2
4	3	2	1	-	-	-	-	-	-	-	-	1	-	2
5	3	2	1	-	-	-	-	-	-	-	-	1	-	2

UNIT I **9 Hours**

FUNDAMENTALS OF DATA COMMUNICATION AND NETWORKS

Data communications - Protocols and Standards-Network devices and Topology- Open System Interconnection model of ISO- Data link control protocol- Media Access protocol-TCP/IP-PI Interface systems.

UNIT II **9 Hours**

INDUSTRIAL NETWORKS

Industrial Ethernet - DeviceNet: Architecture-Physical layer- Data link layer- Actuator Sensor (AS) interface - CAN bus: Architecture-Data handling-message frame.

UNIT III **9 Hours**

HART AND FIELD BUS

HART communication protocol - HART networks - HART commands - HART multidrop mode- HART applications - Fieldbus - Introduction - General Fieldbus architecture - Basic requirements of Fieldbus standard - Fieldbus topology - Interoperability - Interchangeability

UNIT IV **9 Hours**

MODBUS AND PROFIBUS

MODBUS protocol structure - function codes- troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model - communication objects - system operation - troubleshooting - Data Highway.

UNIT V **9 Hours**

NETWORK SECURITY AND CRYPTOGRAPHY

Network security: Security services, Cryptography: Symmetric key cryptography, Security in the Internet: IP Security & Firewalls.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks Design, Installation and Troubleshooting Newnes Publication, Elsevier First Edition, 2004.
2. William Buchanan, Computer Buses, CRC Press, 2000.
3. Behrouz Forouzan, Data Communications & Networking ,3RD edition, Tata McGraw Hill, 2006.
4. W.Stallings, Data & Computer Communications, PHI, 9th Edition, 2011.
5. W.Stallings, Cryptography & Network Security, Pearson, 5th Edition, 2011.

22EI707 PROJECT WORK I 0 0 4 2

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirements, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare report and present the oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3	3	1	3	3	3	3	3	-	2	3	3
2	2	2	3	3	1	3	3	3	3	3	-	2	3	3
3	2	2	3	3	3	3	3	3	3	3	2	2	3	3
4	2	2	3	3	3	3	3	3	3	3	2	2	3	3
5	2	2	-	-	2			3	3	3	-	2	3	3

22EI801 PROJECT WORK II **0 0 20 10**

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11.Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Develop the solutions for real world problems
2. Develop the technical ideas, strategies and methodologies to solve the real world problems
3. Apply the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Test and validate through conformance of the developed prototype and analysis the cost-effectiveness.
5. Prepare report and present the oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2	-		2	2	2	-	-	1	1
2	1	2	1	1	2	-	-	2	2	2	-	-	1	1
3	1	2	1	1	2	-	-	2	2	2	2	-	1	1
4	1	2	1	1	2	-	-	2	2	2	2	-	1	1
5	1	2	-	-	2	-	-	2	2	2	-	-	1	1

22HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills
- Increase ability to comprehend complex content
- Enhance confidence in expressing with clarity and elegance
- Enthusiastic and reflective use of the language through sufficient and focused practice
- Articulate fluently and confidently in challenging situations

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Interpolate and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	3	-	-
2	-	-	-	-	-	-	-	-	3	3	-	3	-	-
3	-	-	-	-	-	-	-	-	3	3	-	3	-	-
4	-	-	-	-	-	-	-	-	3	3	-	3	-	-
5	-	-	-	-	-	-	-	-	3	3	-	3	-	-

UNIT I **15 Hours**

SELF-EXPRESSIONRESSION

Personal Goals and Values - Being a Team Player-Expressing strengths and Weaknesses-Abstract nouns - Adjectives-Active Listening Skills-Note Making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional Ethics-Reported Speech- Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses- Hypothetical questions and Answers-Sentence Structure-Simple Present Tense-Perfect tense

UNIT II **15 Hours**

CREATIVE EXPRESSION

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/ services, Giving directions, Process writing, Sequencing experiments, Concept Explanation-Reported Speech-Voice Sentence Equivalence-Proofreading

UNIT III **15 Hours**

FORMAL EXPRESSION

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements Decoding - Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22HSH01 HINDI 1 0 2 2

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-

UNIT I **9 Hours**

VOWELS AND CONSONANTS

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes -Directions -Seasons Professions.

UNIT V **9 Hours**

CONVERSATIONS

Speaking -Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

22HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen and identify individual sounds of German
2. Use basic phonemes and words while speaking
3. Read and understand short passages on familiar topics
4. Use basic sentence structures while writing
5. Illustrate basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

UNIT V **9 Hours**

IMPLEMENTATION

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

22HSJ01 JAPANESE **1 0 2 2**

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions -Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II **9 Hours**

TIME EXPRESSION / VERBS - PAST

Introduction to time -Introduction of verbs -Listening to specific information

UNIT III **9 Hours**

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation

Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V **9 Hours**

CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours

Reference(s)

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

22HSF01 FRENCH **1 0 2 2**

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and infer short passages on familiar topics
5. Interpret and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

1. Grammaire Progressive du Francais, CLE International, 2010.
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette.
4. Reussir le DELF A1 Bruno Girardeau.
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001.

22EI001 / 22EIH01 / 22EIM01 SMART SENSORS **3 0 0 3**

Course Objectives

- To impart knowledge about various sensors in multidisciplinary engineering domain
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply knowledge of microcontrollers (MCUs) and digital signal processors (DSPs) to interface and control sensors effectively.
2. Analyze different sensor communication methods and MEMS technologies used in intelligent and automated systems.
3. Evaluate recent trends and standards in smart sensors for applications like plug-and-play sensing, web-based control, and smart loops.
4. Design and implement systems using 2D/3D vision sensors, LiDAR, and dust measurement sensors for industrial monitoring and inspection.
5. Conduct experiments for presence and absence detection using smart motion sensors, encoders, and safety light curtains.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	-	3	-	-	-	-	-	-	-	-	-	-	2	-
3	-	-	3	-	-	-	-	-	-	-	-	-	2	-
4	-	-	-	3	-	-	-	-	-	-	-	-	2	-
5	-	-	-	3	2	1	-	-	1	1			2	-

UNIT I **8 Hours**

MCUS AND DSPS FOR SENSOR

Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

UNIT II **8 Hours**

SENSOR COMMUNICATION AND MEMS

Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors – sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

UNIT III **9 Hours**

IMPLICATIONS OF SMART SENSOR STANDARDS AND RECENT TRENDS

Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

UNIT IV **10 Hours**

PRESENCE ABSENCE DETECTION AND IDENTIFICATION

Motion control sensors – Encoders Rotary/Absolute/Programmable-1D/2D Barcodes, RFID Tags Identification- Area Guarding using DeTec4 Safety Light Curtains- Safety Functionality using smart sensor.

UNIT V **10 Hours**

VISION AND DUST MEASUREMENT

2D Vision Smart Camera sensor - OCR Reading and Quality Inspection- 3D Vision camera sensor – Long Distance Measurement Sensor- LiDAR Scanner- Dust Measurement Device for Continuous Emission Measurement.

Total: 45 Hours

Reference(s)

1. Edward Sazonov, Michael R. Newman, Wearable Sensors: Fundamentals, Implementation and Applications, 2014, 1st Edition, Academic Press, Cambridge.
2. Kate Hartman, Make: Wearable Electronics: Design, prototype, and wear your own interactive garments, 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, Flexible Electronics: From Materials to Devices, 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.

22EI002 / 22EIH02 / 22EIM02 IoT PROTOCOLS AND INDUSTRIAL SENSORS

3 0 0 3

Course Objectives

- Understand the basic principles, architectures, physical and logical designs of IoT.
- Explain the IoT communication principles and their protocols.
- Explain the transport and application layer principles and their protocols.
- Understand the working principles of motion, proximity and ranging sensors.
- Explain the principles of force, magnetic and heading sensors and its case studies with real time applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the concepts of IoT Architecture, physical design, logical design and their technologies.
2. Analyze the working principles & concepts of IoT Communication Protocols.
3. Analyze the working principles & concepts of Transport and Application layer Protocols.
4. Apply the various sensors in the Automotive and Mechatronics applications.
5. Analyze the working principles and characteristics of force, magnetic and heading sensors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	-	1
2	1	2	3	2	-	-	-	-	-	-	-	-	-	1
3	2	2	2	2	-	-	-	-	-	-	-	-	-	2
4	2	2	2	2	-	-	-	-	-	-	-	-	-	2
5	2	2	2	2	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO IoT

Architectural Overview- IoT applications- Sensing - Actuations -Basics of Networking - M2M and IoT Technology fundamentals - Devices and gateways - Design of Internet of Things: Physical Design of IoT, Logical Design of IoT - IoT Enabling Technologies.

UNIT II **9 Hours**

IoT COMMUNICATION PROTOCOLS

IoT Data Link Layer & Network Layer Protocols, PHY/MAC Layer -3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN.

UNIT III **9 Hours**

TRANSPORT

Transport Layer Protocols-Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP, SCADA, Authentication Protocols; IEEE 802.15.4, REST and Websocket.

UNIT IV **9 Hours**

MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors - Potentiometers, Resolver, Encoders - Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT - Synchro, Microsyn, Accelerometer, GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons.

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

IoT applications in home appliances, infrastructures, buildings, security, Industries 4.0

Total: 45 Hours

Reference(s)

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands on Approach, University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Peter Waher, Learning Internet of Things, Packt Publishing, UK, 2015.
4. Adrian McEwen, Hakim Classically, Designing the Internet of Things, Wiley Publishing, 2015.
5. Dieter Uckelmann, Mark Harrison and Florian Michahelles, Architecting the Internet of Things, Springer, New York, 2011.

22EI003 / 22EIH03 / 22EIM03 IoT PROCESSORS 3 0 0 3

Course Objectives

- To learn embedded system architecture with its application software.
- To understand ARM and cortex-m3 Architecture.
- To learn about various Cortex exception handling and interrupts.
- To build simple cortex-m3/m4 programming.
- To understand cortex-m3/m4 development and debugging tools.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the embedded system architecture with its application software.
2. Analyze ARM and cortex-M3 architecture and bus.
3. Analysis cortex exception handling and interrupts.
4. Apply concept of Cortex-M3/M4 Programming for a simple application.
5. Analyze Cortex-M3/M4 Development and Debugging Tools.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	-	-	-	-	-	-	-	-	-	1	-
2	2	3	2	-	2	-	-	-	-	-	-	-	2	-
3	2	3	2	-	2	-	-	-	-	-	-	-	2	-
4	2	2	2	-	2	-	-	-	-	-	-	-	1	-
5	2	1	-	3	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION TO EMBEDDED CONCEPTS

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Hardware architecture, Software architecture.

UNIT II **9 Hours**

OVERVIEW OF ARM AND CORTEX M3

Background of ARM Architecture, Processor Naming, Instruction Set Development,Thumb-2 and Instruction Set Architecture.Cortex-M3 Instruction Sets.Cortex-M3 Implementation Overview:Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, D Code Bus, System Bus.

UNIT III **9 Hours**

CORTEX EXCEPTION HANDLING AND INTERRUPTS

Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts, Interrupt/Exception Sequences.

UNIT IV **9 Hours**

CORTEXM3/M4 PROGRAMMING

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard). Exception Programming: Using Interrupts,Exception/Interrupt Handlers. Memory Protection Unit, MPU Registers, Setting Up the MPU.

UNIT V **9 Hours**

CORTEXM3/M4 DEVELOPMENT AND DEBUGGING TOOLS

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control.STM32L15xxx, Peripherals: GPIOs, System Configuration Controller, Comparators, USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger.

Total: 45 Hours

Reference(s)

1. Joseph Yiu,The Definitive Guide to the ARM Cortex-M3,Second Edition,Elsevier Inc, 2010.
2. Andrew N Sloss,Dominic Symes,Chris Wright,ARM System Developers Guide Designing and Optimizing System Software,Elsevier Publications, 2006.
3. Steve Furber,ARM System-on-Chip Architecture,2nd Edition, Pearson Education,India ISBN:9788131708408,8131708403, 2015.
4. Dr.K.V.K.Prasad,Embedded/Real Time Systems:Concepts,Design and Programming Black Book,New edition (MISL-DT) Paperback 12 Nov 2003.
5. David Seal ARM Architecture Reference Manual Addison Wesley England Morgan Kaufmann Publishers, 2001.

22EI004 / 22EIH04 / 22EIM04 IoT SYSTEM DESIGN 3 0 0 3

Course Objectives

- To learn how to design and implement IoT applications that manage big data, streaming data, and/or distributed data.
- To understand Smart Objects and IoT Architectures.
- To learn about various IoT-related protocols.
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT.
- To develop IoT infrastructure for popular applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the fundamentals of IoT and its architecture.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Rasperry Pi/Arduino.
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	-	-	-	-	-	-	-	-	-	1	-
2	2	3	2	-	2	-	-	-	-	-	-	-	2	
3	2	3	2	-	2	-	-	-	-	-	-	-	3	2
4	2	2	-	2	-	-	-	-	-	-	-	3	2	2
5	1	-	3	-	-	-	-	-	-	-	-	3	2	2

UNIT I **9 Hours**

FUNDAMENTALS OF IoT

Evolution of Internet of Things, Enabling Technologies, IoT Architectures: Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

UNIT II **9 Hours**

IoT PROTOCOLS

IoT Access Technologies: IEEE 802.15.4, 802.15.4e, Zigbee protocol, IP versions, CoAP and MQTT. Modern databases: No SQL, New SQL, MongoDb.

UNIT III **9 Hours**

DESIGN AND DEVELOPMENT

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino Board details, IDE programming, Raspberry Pi and Interfaces.

UNIT IV **9 Hours**

DATA ANALYTICS AND SUPPORTING SERVICES

Role of Machine Learning: Hadoop Ecosystem, Edge Streaming Analytics and Network Analytics, Google Spreadsheet for IoT & Analytics, ThingSpeak and Firebase, Cloud for IoT, Python Web Application Framework.

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

Cisco IoT system, IBM Watson IoT platform, Power Utility in Industry, Smart and Connected Cities: Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

Total: 45 Hours

Reference(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals:Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things - A hands-on approach, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, DavidBoyle, From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence, Elsevier, 2014.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
6. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O Reilly Media, 2011.

22EI005 / 22EIH05 / 22EIM05 WIRELESS SENSOR NETWORK DESIGN

3 0 0 3

Course Objectives

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To familiarize with learning of the Architecture of WSN.
- To understand the concepts of Networking and Networking in WSN.
- To study the design consideration of topology control and solution to the various problems.
- To introduce the hardware and software platforms and tool in WSN.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Apply the fundamentals of wireless communication and sensor node architecture to different types of Wireless Sensor Networks.
2. Analyze sensor network architectures, communication models, and performance optimization strategies for effective WSN implementation.
3. Evaluate various protocols (MAC, routing) and address assignment methods for energy-efficient communication in WSNs.
4. Design and implement wireless sensor network applications using sensor platforms, node-level programming, and simulators.
5. Conduct experiments related to network setup, clustering, time synchronization, and security in wireless sensor environments.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
3	-	-	2	-	-	-	-	-	-	-	-	-	1	-

4	-	-	-	2	3	-	-	-	-	-	-	-	1	-
5	-	-	-	-	3	1	-	-	1	1		-	1	-

UNIT I **10 Hours**

OVERVIEW OF WIRELESS SENSOR NETWORKS

Introduction: Fundamentals of wireless communication technology, SingleNode Architecture, Network Characteristics, characteristics of wireless channels, modulation techniques, Types of wireless sensor networks.

UNIT II **10 Hours**

ARCHITECTURES

Network Architecture, Sensor Networks Scenarios, Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Operating Systems and Execution Environments, Internet to WSN Communication.

UNIT III **9 Hours**

NETWORKING SENSORS

Routing protocols, MAC Protocols for Wireless Sensor Network, Low Duty Cycle Protocols and Wakeup Concept, SMAC IEEE 802.15.4 standar, Wakeup Radio Concepts, Address and Name Management Assignment of MAC Addresses, Routing Protocols Energy Efficient Routing, Geographic Routing.

UNIT IV **8 Hours**

INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering Time Synchronization Localization and Positioning Sensor Tasking and Control Real-time traffic support and security protocols.

UNIT V **8 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS

Sensor Node Hardware Berkeley Motes Programming Challenges, Nodelevel software platforms Node level Simulators, StateÃ, Âcentric programming.

Total: 45 Hours

Reference(s)

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Feng Zhao and Leonidas J.Guibas, Wireless Sensor Networks An Information Processing Approach, Elsevier, 2007.
3. Waltenegus Dargie , Christian Poellabauer, Fundamentals of Wireless Sensor Networks Theory and Practice, John Wiley and Sons Publications, 2011.
4. K. Akkaya and M. Younis, A survey of routing protocols in wireless sensor networks, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325-349.
5. Philip Levis, TinyOS Programming.
6. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd.

22EI006 / 22EIH06 / 22EIM06 INDUSTRIAL IoT AND INDUSTRY 4.0 — 3 0 0 3

Course Objectives

- To provide the overview about evolution and importance of Industrial IoT in the era of Industry 4.0.
- To introduce the Industrial IoT reference architectures and Business models in industrial automation systems.
- To understand the on-site key technologies for the requirement of a smart factory.
- To get the knowledge of Industrial IoT data Analytics.
- To apply the technologies of Industrial IoT in various Industries as case studies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply knowledge of Industry 4.0, CPS, and smart technologies like AR/VR and Big Data Analytics to modern manufacturing systems..
2. Analyze industrial automation concepts, IT/OT convergence, and IIoT architectures like IIRA and business models.
3. Evaluate industrial data transmission protocols and computing frameworks such as Edge, Fog, and Cloud for IIoT deployment.
   communication in WSNs.
4. Developing real-world IIoT application modules in various industries through case studies and performance assessment
5. Design and conduct experiments involving data analytics, machine learning, and security threat modeling for IIoT applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	-	-	-	-			1	2
2	-	3	-	-	-	-	-	-	-	-	-		1	1
3	-	-	3	-	-	-	-	-	-	-	-		1	2
4	-	-	-	3									1	2
5	-	-	-	2	1				1	1			1	2

UNIT I **9 Hours**

INTRODUCTION AND KEY TECHNOLOGIES

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologies in Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

UNIT II **9 Hours**

INDUSTRIAL AUTOMATION AND IoT

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIoT, Industrial internet Consortium (IIC).

UNIT III **9 Hours**

INDUSTRIAL DATA TRANSMISSION AND COMPUTING

Foundation Fieldbus, Profibus, CC-link, MODBUS, DigitalSTROM, CAN, DeviceNet, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

UNIT IV **9 Hours**

DATA ANALYTICS AND SECURITY

Necessity of Analytics and IIoT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIoT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

UNIT V **9 Hours**

APPLICATIONS OF IIoT

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing Industry, Automotive Industry, Mining Industry, Textile Industry.

Total: 45 Hours

Reference(s)

1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist (Apress), 2017.
2. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017.
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
4. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
5. Ortiz, JesÃƒÂºs Hamilton. "Industry 4.0: Current status and future trends", 2020.
6. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.

22EI007 / 22EIH07 / 22EIM07 DATA ANALYTICS FOR IoT

3 0 0 3

Course Objectives

- To understand the basics of nature of data.
- To understand basic operation in data analysis using python.
- To understand data manipulation using pandas library.
- Data visualization using different types of charts.
- To understand basic python program for IoT application.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the nature of the data processing quantitatively and qualitatively using python.
2. Analyze the various data operations performed using NumPy library.
3. Analyze the data manipulation process using pandas library in python.
4. Apply data visualization techniques to interpret the data with various parameters.
5. Construct IoT projects using python and Raspberry Pi.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	-	-	-	-	-	-	-	-	-	2	-
2	2	3	2	-	3	-	-	-	-	-	-	-	2	2
3	2	3	2	3	3	-	-	-	-	-	-	-	2	2
4	2	2	2	3	3	-	-	-	-	-	-	-	3	-
5	2	1	-	3	2	-	-	-	1	1	-	-	3	-

UNIT I **9 Hours**

INTRODUCTION TO DATA ANALYSIS AND PYTHON

Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative, Data Analysis Python and Data Analysis, Installing Python, and writing Python Code, IPython, The IDEs for Python SciPy.

UNIT II **9 Hours**

BASIC OPERATIONS USING PYTHON

The NumPy Library, The NumPy Installation, Basic Operations Indexing, Slicing, and Iterating Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, General Concepts, Structured Arrays, Reading and Writing Array Data on Files

UNIT III **9 Hours**

DATA ANALYSIS

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files

UNIT IV **9 Hours**

DATA MANUPULATION

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

UNIT V **9 Hours**

DATA VISUALIZATION

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

Total: 45 Hours

Reference(s)

1. Fabio Nelli, Python Data Analytics, APRESS, 2015.
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK, 2020.
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK, 2015.
4. Peters Morgan,Data Analysis from Scratch with Python, AI Sciences, 2016.
5. Agus kurniawan,Micropython for ESP8266 Development workshop, PE PRESS, 2016.
6. Charles Bell, MicroPython for the internet of Things, Apress, 2017.

22EI008 ROBOTICS AND AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with the design, functioning and applications of robots.
- To differentiate the robotic sensors, actuators and end-effectors.
- To formulate the control algorithms and path planning algorithms for the robots.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the evolution of robotics.
2. Analyze the basic concepts associated with the design, functioning and applications of robots.
3. Apply the kinematics of a robotic manipulator.
4. Design the control algorithms and path planning algorithms for the robots.
5. Select the suitable sensor, actuator and gripper for the robot.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	3	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	3

UNIT I **8 Hours**

FUNDAMENTALS OF ROBOTICS

Automation and robots - a brief history of robotics - definition and laws of robotics - anatomy of robot - robot classifications - robot specifications - robot configurations - robot links - robot joints - performance parameter - applications of robots.

UNIT II **11 Hours**

ROBOT KINEMATICS

Robot architecture - pose of a rigid body - coordinate transformation - homogenous coordinates - Denavit and Hartenborg (DH) parameters - forward position analysis - inverse position analysis - velocity analysis: The Jacobian matrix, link velocities, singularity - acceleration analysis. Mobile robots dynamics (Newtonian dynamics).

UNIT III **8 Hours**

ROBOT POWER SOURCES AND END EFFECTOR

Power Sources: Hydraulic, pneumatic and electric drives - mechanical transmission-gear transmission, belt drives, cables, roller chains, rotary to linear motion conversion, rotary to rotary motion conversion. End Effector: Types of end effector - mechanical grippers - vacuum cups - magnetic grippers - adhesive grippers - hooks, scoops, miscellaneous devices - tools as end effector - the robot end effector interface - selection and design of the gripper.

UNIT IV **8 Hours**

ROBOTIC SENSORS AND VISION

Sensors in robotics - classification - tactile, proximity and range sensors - sensors based systems; Introduction to machine vision - the sensing and digitizing function in machine vision - image processing and analysis - training the vision system - robot programming and languages

UNIT V **10 Hours**

PATH PLANNING, CONTROL OF ROBOTIC MANIPULATORS AND APPLICATIONS

Considerations on trajectory planning - joint interrelated trajectories - cartesian path trajectories - control of robot - PID control - computed torque technique - Multiple robots - Machine interface Robots in manufacturing and non-manufacturing application - Robot cell design - selection of a robot.

Total: 45 Hours

Reference(s)

1. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Prentice Hall of India Private Limited, New Delhi, 2010.
2. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, Industrial Robotics, Tata McGraw-Hill Education, 2012.
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2013.
4. K S Fu,Ralph Gonzalez,C S G Lee, Robotics: Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Education, 2010.
5. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering - An integrated approach, Prentice Hall of India, New Delhi, 2012.
6. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, Springer-Verlog Berlin Heidelberg, 2008.

22EI009 BUILDING AUTOMATION **3 0 0 3**

Course Objectives

- To understand the principles and application of Building Automation system and building process control.
- To study the dynamic performance of fire alarm system and various access control systems.
- To get knowledge in security systems of different applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Develop HVAC system architecture for building automation with human comfort.
2. Demonstrate and analyze the process model for heating, cooling and ventilation applications.
3. Design and develop different architecture of fire alarm system using field and panel components.
4. Select the appropriate CCTV access control system design for different applications in security system aspects.
5. Apply perimeter intrusion technology for advanced security system design applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	3	-	-	-	-	-	-	-	-	-	1	1
2	2	-	2	-	-	-	-	-	-	-	-	-	2	1
3	1	-	2	-	-	-	-	-	-	-	-	-	1	1
4	2	-	2	-	-	-	-	-	-	-	-	-	2	1
5	3	-	2	-	-	-	-	-	-	-	-	-	2	1

UNIT I **9 Hours**

INTRODUCTION TO BUILDING AUTOMATION SYSTEM

Fundamentals: Introduction to HVAC - Basic Processes (Heating, Cooling) - Air Properties - Psychometric Chart - Heat Transfer mechanisms - Human Comfort: Human comfort zones - Effect of Heat, Humidity - Heat loss

UNIT II **9 Hours**

PROCESSES

Heating Process & Applications: Boiler, Heater - Cooling Process and Applications: Chillers - Ventilation Process and Applications - Central Fan System - AHU - Exhaust Fans - Unitary Systems - VAV, FCU - Energy Saving concept & methods - Lighting control - Building efficiency improvement - Green Building - Leadership in Energy and Environmental Design (LEED) Certification concept and examples

UNIT III **10 Hours**

FIRE ALARM SYSTEM (FAS)

Introduction to fire alarm system - Fire modes, Principles of operation, FAS Components: Field Components, Panel Components and Applications. Power Supply design for FAS. Cause & effect matrix: Examples. Fire Standards: NFPA 72A, BS 5839, Indian Standards

UNIT IV **9 Hours**

SECURITY SYSTEMS

Introduction to Security Systems, Concepts of Access Control System: Access Components, Access control system Design. CCTV: Camera: Operation & types, Camera Selection Criteria, NVR / SAN / Unified storage based design, DVM, Network design, Storage design and CCTV Applications

UNIT V **8 Hours**

PERIMETER INTRUSION SYSTEM

Concept, Components, Technology and Advanced Applications Security Design: Security system design for verticals

Total: 45 Hours

Reference(s)

1. Reinhold A. Carlson, Robert A. Di Giandomenico, Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs), R.S. Means Company, Inc 2012.
2. William B. Riddens, Understanding Automotive Electronics, Sixth Edition, Butterworth Heinemann Woburn, 2010.
3. Michael F. Hordeski, HVAC Control in the New Millennium, First edition, Fairmont Press, 2011.
4. NJATC Building Automation Control Devices and applications, First edition, Amer Technical Pub, 2012.

22EI010 INTELLIGENT AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with Robotic Process Automation.
- To develop practical skills in using RPA tools and platforms to automate repetitive tasks, streamline business processes, and improve operational efficiency.
- To develop skills in implementing intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the basic concepts of Intelligent Automation, applications and implementation procedures.
2. Implement intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.
3. Design and deploy intelligent automation systems.
4. Outline the advanced topics in intelligent automation, such as cognitive automation, robotic process automation (RPA), and adaptive automation.
5. Apply theoretical knowledge and practical skills to develop innovative solutions that maximize operational efficiency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	2
2	3	1	2	1	-	-	-	-	-	-	-	-	-	2
3	3	1	2	2	-	-	-	-	-	-	-	-	-	2
4	3	1	2	3	-	-	-	-	-	-	-	-	-	2
5	3	1	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

INTRODUCTION TO INTELLIGENT AUTOMATION

Introduction to Intelligent Automation(IA) - Differentiating IA from AI - IA technologies - implementation of IA - IA use cases.

UNIT II **9 Hours**

AI TECHNOLOGIES FOR INTELLIGENT AUTOMATION

Introduction to AI technologies used in IA such as natural language processing, computer vision, predictive analytics. AI implementation in robotics.

UNIT III **10 Hours**

INTELLIGENT PROCESS AUTOMATION

Introduction to IPA-Differences between IPA and RPA-Benefits of IPA-Role of Intelligent Process Automation in Automation-Server based robots-Intelligent workflow solutions that aid in management, integration and handoff processes-cognitive agents-optical character recognition-chatbots.

UNIT IV **10 Hours**

COGNITIVE AUTOMATION AND DECISION MAKING

Fundamentals and principles - interdisciplinary nature of cognitive science - representations for information and knowledge - principal technology enablers for cognitive computing - cognitive computing architectures, approaches, applications. Cognitive computing and neural networks - adaptive automation.

UNIT V **8 Hours**

APPLICATIONS

Case studies and real-world examples of successful intelligent automation implementations

Total: 45 Hours

Reference(s)

1. Bornet, Pascal & Barkin, Ian & Wirtz, Jochen, Intelligent Automation - Learn How to Harness Artificial Intelligence to Boost Business & Make Our World More Human, 2020.
2. Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach. Prentice Hall, 2010.
3. Vijay Raghavan, Venkat Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications, 2016.
4. Alok Mani Tripathi, Learning Robotic Process Automation, Packt Publishing, 2018.
5. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Independently Published, 1st Edition, 2018.

22EI011 SMART MANUFACTURING 3 0 0 3

Course Objectives

- To develop a comprehensive understanding of smart manufacturing concepts, technologies, and their impact on the industry.
- To implement and manage smart manufacturing systems, including IoT connectivity, data analytics, and advanced manufacturing technologies.
- To apply theoretical knowledge and practical skills to optimize production processes, enhance quality control, and drive efficiency and productivity in smart manufacturing environments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Demonstrate smart manufacturing principles, technologies, and their application in real-world scenarios.
2. Implement connectivity solutions and leverage the Internet of Things (IoT) to enable seamless communication and collaboration among machines, systems, and stakeholders.
3. Apply data analytics and artificial intelligence techniques to optimize manufacturing processes, improve product quality, and enable predictive maintenance.
4. Evaluate and select appropriate advanced manufacturing technologies, such as additive manufacturing and robotics, to enhance production efficiency and flexibility.
5. Design and execute strategies for the successful implementation and management of smart manufacturing systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	2
2	3	1	2	1	-	-	-	-	-	-	-	-	-	2
3	3	1	2	2	-	-	-	-	-	-	-	-	-	2
4	3	1	2	3	-	-	-	-	-	-	-	-	-	2
5	3	1	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

INTRODUCTION

Smart manufacturing - implementing smart manufacturing across an industry - Industry 4.0 and international perspective - role of hardware and software in smart manufacturing.

UNIT II **10 Hours**

INDUSTRIAL IOT AND CONNECTIVITY IN SMART MANUFACTURING

Industrial Internet of Things and Cyber Manufacturing Systems(CMS) - Cyber Physical systems(CPS) engineering for manufacturing - Model-Based Engineering of Supervisory Controllers for Cyber- Physical Systems .CPS-Based Manufacturing with Semantic Object Memories and Service Orchestration for Industry4.0 Applications - Integration of a Knowledge Database and Machine Vision within a Robot-Based CPS - Interoperability in Smart Automation of Cyber Physical Systems - Communication and Networking for the Industrial Internet of Things.

UNIT III **10 Hours**

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS FOR MANUFACTURING

Application of CPS in machine tools - Manufacturing CPS (IIOT) - CPS intelligence - Big Data and Machine Learning for the Smart Factory - Solutions for Condition Monitoring, Diagnosis and Optimization - Overview of the CPS for Smart Factories Project: Deep Learning, Knowledge Acquisition, Anomaly Detection and Intelligent User Interfaces.

UNIT IV **8 Hours**

ADVANCED MANUFACTURING TECHNOLOGIES IN SMART MANUFACTURING

Introduction and basic principles - Development of Additive Manufacturing Technology - Generalized Additive Manufacturing Process Chain - Rapid prototyping - Direct Digital Manufacturing - Applications for Additive Manufacture.

UNIT V **9 Hours**

SMART MANUFACTURING TECHNOLOGIES FOR INDUSTRY 4.0

Organizational Transformation towards Industry 4.0 Technologies-The Autonomy of Autonomous Robots-Smart Technologies for Industry 4.0 and Its Future. Digital Twin-Based Smart Manufacturing-Concept and Applications.

Total: 45 Hours

Reference(s)

1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Concepts and Methods, Elsevier, 2020.
2. Sabina Jeschke,Christian Brecher,Tobias Meisen,Denis ozdemir,Tim Eschert,Industrial Internet of Things,Springer, 2017.
3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2015.
4. Jayakrishna Kandasamy, Kamalakanta Muduli, V. P. Kommula, Purushottam L. Meena, Smart Manufacturing Technologies for Industry 4.0: Integration, Benefits, and Operational Activities, Taylor and Francis, 2023.

22EI012 AI AND EXPERT SYSTEM FOR AUTOMATION

3 0 0 3

Course Objectives

- To understand the fundamentals of artificial intelligence (AI) and expert systems in the context of automation.
- To implement and train machine learning models for automation tasks.
- To design and develop rule-based expert systems for automation decision-making.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Interpret the history, applications, and ethical considerations of AI in automation.
2. Implement and train machine learning models for automation tasks.
3. Interpret the concepts and techniques of expert systems and knowledge representation in automation.
4. Apply natural language processing (NLP) techniques in automation to enable human-computer interaction and language understanding.
5. Investigate real-world applications of AI and expert systems in various industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	-	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO AI AND EXPERT SYSTEMS

Definition and scope of AI - .History and evolution of AI - AI applications in various industries - Ethical considerations in AI - Problem-solving methods in AI - Search algorithms, including depth-first search, breadth-first search, and A* search - Heuristic search and informed search techniques - Constraint satisfaction problems and algorithms

UNIT II **8 Hours**

EXPERT SYSTEMS AND KNOWLEDGE REPRESENTATION

Components and architecture of expert systems- Knowledge representation and reasoning techniques - Rule-based systems and inference engines - Integration of expert systems with other AI techniques

UNIT III **10 Hours**

MACHINE LEARNING ALGORITHMS FOR AUTOMATION

Introduction to machine learning and its relation to expert systems - Supervised, unsupervised, and reinforcement learning algorithms - Training and evaluation of machine learning models - Integration of machine learning with expert systems

UNIT IV **10 Hours**

NATURAL LANGUAGE PROCESSING FOR AUTOMATION

Introduction to natural language processing (NLP) - NLP techniques for language understanding and generation - NLP applications in expert systems, such as chatbots and language-based decision-making-Sentiment analysis and opinion mining in expert systems.

UNIT V **8 Hours**

APPLICATIONS

Process automation-Decision support system-predictive maintenance-supply chain optimization-quality control and inspection-Case study: Develop a comprehensive medical knowledge base containing information information on various diseases, symptoms, risk factors and treatments.

Total: 45 Hours

Reference(s)

1. Joseph C. Giarratano and Gary D. Riley , Expert Systems: Principles and Programming, 4th Edition, 2022.
2. Stuart Russell and Peter Norvig , Artificial Intelligence: A Modern Approach, Pearson, 2010.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. Daniel Jurafsky and James H. Martin,Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 2nd edition, Pearson, 2013.

22EI013 INTELLIGENT CONTROL 3 0 0 3

Course Objectives

- To understand the intelligent control techniques and their applications in various domains.
- To design and implement fuzzy logic, neural network, and genetic algorithm-based controllers.
- To apply intelligent control methodologies to address real-world control problems, enhancing system stability, robustness, and responsiveness.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Interpret the intelligent control principles and techniques.
2. Design and implement intelligent control systems using fuzzy logic.
3. Design and implement intelligent control systems using neural network.
4. Design and implement intelligent control systems using genetic algorithm.
5. Outline the challenges in practical implementation of intelligent control system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	-	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO INTELLIGENT CONTROL

Overview of control systems and their significance in various domains - Introduction to intelligent control and its applications - Comparison of conventional control and intelligent control approaches - Ethical considerations and challenges in implementing intelligent control systems.

UNIT II **10 Hours**

NEURAL NETWORK CONTROL

Introduction to artificial neural networks and their architectures - Neural network-based control approaches, such as adaptive control and model predictive control - Training and learning algorithms for neural network controllers - Case studies and applications of neural network control.

UNIT III **9 Hours**

FUZZY LOGIC CONTROL

Introduction to fuzzy logic and fuzzy sets - Fuzzy logic control architecture and inference mechanisms. Design and tuning of fuzzy logic controllers - Applications of fuzzy logic control.

UNIT IV **9 Hours**

GENETIC ALGORITHM CONTROL

Introduction to genetic algorithms and evolutionary optimization - Genetic algorithm-based control strategies, including PID tuning and optimal control - Encoding, selection, crossover, and mutation operations in genetic algorithms - Applications of genetic algorithm control in complex systems.

UNIT V **8 Hours**

INTELLIGENT CONTROL SYSTEM INTEGRATION AND OPTIMIZATION

Integration of different intelligent control techniques for complex systems - Multi-objective optimization in intelligent control system design - Case studies and practical implementation challenges.

Total: 45 Hours

Reference(s)

1. Jagannathan Sarangapani., Neural Network Control of Nonlinear Discrete-Time Systems, CRC press, 2017.
2. Derong Liu and Panos J. Antsaklis, Intelligent Control Systems: An Introduction with Examples, 2004.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley, 2010.
4. Xinjie Yu, Mitsuo Gen, and Runwei Cheng, Introduction to Evolutionary Algorithms, Springer, 2010.
5. Pedro Ponce-Cruz and Fernando D. Ramirez-Figueroa, Intelligent Control Systems with LabVIEW, Springer, 2010.

22EI014 ANALYTICAL INSTRUMENTS 3 0 0 3

Course Objectives

- To understand the various techniques and methods of analysis that occurs in the various regions of the spectrum.
- To impart an adequate knowledge about chromatography method for analysis of industrial gases.
- To understand the concepts of interaction of electromagnetic radiation with matter.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Select the appropriate spectrophotometer techniques for analysing concentration of chemical solution.
2. Differentiate the chromatographic techniques used for industrial applications.
3. Select specific techniques employed for analyzing gas, dissolved component and monitoring different pollutants in air and water.
4. Compare three different electrodes and analyzers used for the detection of silicon, sodium and dissolved oxygen.
5. Choose the appropriate radiation techniques (NMR, ESR, and EPR) to determine the elements present in the sample.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	2	2	1	-	-	-	1	2	-
2	3	2	-	-	-	2	2	1	-	-	-	1	2	-
3	3	-	-	-	-	2	2	1	-	-	-	1	2	-
4	3	-	-	-	-	2	2	1	-	-	-	1	2	-
5	3	-	-	-	-	2	2	1	-	-	-	1	2	-

UNIT I **9 Hours**

COLORIMETRY AND SPECTROPHOTOMETRY

Beer-Lambert''s law - colorimeters - basic principle of spectroscopy -Emission and absorption of radiation sources and detectors - UV and visible spectrophotometers - single and double beam instruments - IR spectrophotometers - attenuated total reflectance flame photometers - atomic absorption spectrophotometers - FTIR spectrophotometers - flame emission photometers.-mass spectrophotometers.

UNIT II **7 Hours**

CHROMATOGRAPHY

Gas chromatography - Detectors - Liquid chromatography - Applications - High pressure liquid chromatography – Applications.

UNIT III **10 Hours**

GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS

Gas analyzer: oxygen, NOx and H2S types, IR analyzers, thermal conductivity analyzers - air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides and sulphur dioxide estimation - dust and smoke measurements.

UNIT IV **9 Hours**

PH CONDUCTIVITY AND DISSOLVED COMPONENT ANALYZER

Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors - dissolved oxygen analyzer - sodium analyzer - silicon analyzer.

UNIT V **10 Hours**

NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES

Nuclear radiation - microwave spectroscopy - NMR, ESR and EPR spectroscopy - applications - nuclear radiation detectors - GM counter - proportional counter - solid state detectors - X-ray spectroscopy - detectors - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM).

Total: 45 Hours

Reference(s)

1. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 2nd Edition, 2006.
2. G.W. Ewing, Instrumental Methods of Analysis, McGraw Hill, 2004.
3. Liptak, B.G., Process Measurement and Analysis, CRC Press, 2005.
4. Braun, R.D., Introduction to Instrumental Analysis, McGraw Hill, Singapore, 2006.
5. H.W.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, PHI, 2005.

22EI015 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To provide an overview of Virtual instruments.
- To bring out the overview of the software.
- To know about the programming structure of the software.
- To familiarize the student with the Applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the basics of Virtual or graphical instrumentation concepts.
2. Analyze the overview of G programming, labels, data types and debug the G programming.
3. Select the appropriate structuring concept to be used in graphical programming.
4. Organize the procedure to install DAQ in various OS and its interfacing methods.
5. Implement the IMAQ Motion control and machine vision concepts for industrial application.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	1	1	1	-	-	-	1	-	-	1	1	1
3	1	3	3	2	3	-	-	-	1	-	-	2	2	2
4	1	3	2	3	3	-	-	-	1	-	-	2	2	3
5	1	3	3	3	3	-	-	-	1	-	-	2	2	3

UNIT I **9 Hours**

INTRODUCTION

General functional description of digital instrument - Block diagram of a Virtual Instrument - Advantages of Virtual Instruments over conventional instruments - Architecture of a Virtual Instrument and a its relation to the operating system. Advantages of Virtual Instruments over conventional instruments

UNIT II **9 Hours**

SOFTWARE OVERVIEW

VI-Graphical user interfaces-Controls and indicators-G programming-Labels and Text-Shape,size and color-Owned and free labels-Data type,Format,Precision and representation-Data types-Data flow programming-Editing-Debugging and Running a Virtual Instrument-Graphical programming palettes and tools-Front panel objects-Data types

UNIT III **9 Hours**

PROGRAMMING STRUCTURE

FOR Loops, WHILE Loops, CASE Structure, Formula nodes, Sequence structures - Arrays and Clusters - Array Operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O"s - Attribute modes Local and Global variables. Bundle/Unbundle by name

UNIT IV **9 Hours**

OPERATING SYSTEM AND HARDWARE ASPECTS

Current trends Operating system requirements - Data Acquisition Card(DAQ): DAQ hardware, Grounding methods, Resolution, Analog I/O, Digital I/O - DAQ Software Architecture - Configuring the DAQ hardware/software for temperature measurement.

UNIT V **9 Hours**

APPLICATIONS

IMAQ Motion Control: components of a motion control system, configuration, prototyping and development - Interfacing Servomotor and Stepper motor in LabVIEW. Machine Vision: Edge Detection.

Total: 45 Hours

Reference(s)

1. 1. Garry M Johnson, Labview Graphical Programming, Tata McGraw Hill book Co, New Delhi, 2017.
2. Jovitha Jerome, Virtual Instrumentation Using LabVIEW PHI Learning Pvt. Ltd 1st Edition, 2010.
3. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming made Easy and Fun, Tata McGraw Hill book Co, New Delhi, 2011.
4. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.

22EI016 INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES **3 0 0 3**

Course Objectives

- To understand the process involved in petroleum refineries.
- To impact adequate knowledge on the distillation column and its control process.
- To understand the controlling concepts of major unit of refineries like distillation column, reactors, driers, heat exchangers, etc.
- To be acquainted with the safety measures in petroleum industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the production and consumption patterns of fossil fuels in India, evaluating their impact on the energy sector and economy.
2. Compare and evaluate different control techniques used in distillation processes in petroleum industries to enhance efficiency and yield.
3. Analyze the characteristics of physical parameters in chemical reactors and apply suitable control mechanisms for process optimization.
4. Analyze the process parameters of heat exchange systems in petroleum industries and apply advanced control strategies for energy efficiency.
5. Assess the significance of safety instrumentation (zone 0, 1, and 2) and develop strategies to mitigate industrial hazards and accidents.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	1	-	-	-	-	-	-	-	-	-
2	3	3	3	2	-	-	-	-	-	-	-	-	-	-
3	3	3	3	2	-	-	-	-	-	-	-	-	2	-
4	3	2	3	2	1	-	-	-	-	-	-	-	2	-
5	2	3	3	1	1	1	1	-	-	-	-	-	2	-

UNIT I **7 Hours**

INTRODUCTION

Formation of oil and gas - Petroleum exploration, production and refining - refining capacity in India - consumption of petroleum products in India - constituents of crude oil

UNIT II **10 Hours**

DISTILLATION PROCESS CONTROL

Introduction to P & I diagram - atmospheric distillation of crude oil with P&I diagram - Separation of crude oil - vacuum distillation process - thermal conversion process - Catalytic conversion - control of distillation column -feed control - reflux control - reboiler control

UNIT III **9 Hours**

REACTORS PROCESS CONTROL

Control of chemical reactors: temperature control, pressure control - Dryers: control of dryers - batch dryers - atmospheric and vacuum dryers - continuous dryers

UNIT IV **10 Hours**

HEAT EXCHANGE SYSTEM

Control of heat exchangers and evaporators - variables and degrees of freedom - liquid to liquid heat exchangers - steam heaters - condensers - reboiler and vaporizers - cascade control - feed forward control - Feedback control- Integrated approach - evaporators: types of evaporators

UNIT V **9 Hours**

SAFETY INSTRUMENTATION

Hazardous and non-hazardous area - classification of zone 0, zone 1 & zone 2 - pressurization techniques - zener barrier

Total: 45 Hours

Reference(s)

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers Ltd, New Delhi, 2007.
2. B.G. Liptak, Instrumentation in Process Industries, Chilton Book Company, New York, 1973.
3. B.G. Liptak, Instrument Engineers Handbook Volume II, 2003.

22EI017 FIBER OPTICS AND LASER INSTRUMENTATION

3 0 0 3

Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication.
- To be recognized with industrial applications of fibers.
- To understand the fundamental concepts about lasers.
- To identify and describe various fiber optic imaging and optoelectronic sensor applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the properties of optical fibers, their light sources, and detectors to optimize signal transmission and efficiency.
2. Apply fiber-optic sensors for the measurement of various physical quantities in industrial applications.
3. Analyze the fundamental principles of lasers, classify different types, and examine their working mechanisms.
4. Analyze the applications of lasers in industrial processes such as material processing, measurement, and pollutant detection.
5. Apply laser instruments in various medical applications and analyse their effectiveness in surgical and therapeutic procedures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
2	3	2	1	2	-	-	-	-	-	-	-	-	2	-
3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
4	3	2	2	2	-	-	-	-	-	-	-	-	-	2
5	3	2	2	2	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Principles of light propagation through a fiber - different types of fibers and their properties - relative merits and demerits - fiber optics production and components - technology of preformed fabrication - fiber drawing - mechanical and thermal characteristics - light sources - photo detectors -source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III **9 Hours**

LASER FUNDAMENTALS

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials – removal and vaporization - calculation of power requirements of laser for material processing

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non- destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology

Total: 45 Hours

Reference(s)

1. J.M. Senior, Optical Fiber Communication - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. G. Keiser, Optical Fiber Communications, McGraw Hill, 2010.
4. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2009.
5. Donald J. Sterling, Technicians Guide to Fiber Optics, Delmar publisher, 2009.
6. Jelinkova, Helena, editor.Lasers for medical applications: diagnostics, therapy and surgery. Elsevier, 2013.

22EI018 POWER PLANT INSTRUMENTATION AND CONTROL 3 0 0 3

Course Objectives

- To gain knowledge on different methods of power generation.
- To provide clear view of the various measurements involved in power generation plants.
- To understand about the Piping and Instrumentation (P&I) diagram.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply different methods of power generation and analyse the basic building blocks of a thermal power plant.
2. Apply suitable measurement techniques for electrical and non-electrical parameters in a thermal power plant and analyse their significance.
3. Apply control schemes for combustion processes, including air-fuel ratio, draught, pulverizer, flue gas dew point, and soot blowing, and analyse their efficiency.
4. Analyze major boiler control schemes for feedwater, drum level, steam temperature, and boiler interlocks to ensure safe and efficient operation.
5. Apply control strategies for nuclear power plants and analyse safety instrumentation and turbine control methods for reliability and efficiency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	2	1
2	2	2	3	1	-	-	-	-	-	-	-	-	3	1
3	1	3	2	1	-	-	-	-	-	-	-	-	3	1
4	1	3	2	1	-	-	-	-	-	-	-	-	2	2
5	1	1	3	3	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

OVERVIEW OF POWER GENERATION

Survey of methods of power generation - hydro, thermal, nuclear, solar and wind power - importance of instrumentation in power generation - thermal power plant - building blocks - combined cycle system-combined heat and power system - sub critical and supercritical boilers-details of boiler processes-P&I diagram of boiler - cogeneration

UNIT II **9 Hours**

MEASUREMENTS IN POWER PLANTS

Electrical measurements - current, voltage, power, frequency, power factor etc.- non electrical parameters -Measurement of feed water flow, air flow, steam flow and coal flow - drum level measurement - steam pressure and temperature measurement - turbine speed and vibration measurement- flue gas analyzer - fuel composition analyzer- pollution monitoring Instruments - dust monitor

UNIT III **9 Hours**

BOILER CONTROL LOOPS I

Coal handling: Pulverizers and Pulverizers control-Furnace Draught control - Combustion control: Fuel/Air ratio, combustion efficiency-oxygen, CO and CO2 trimming, excess air flue gas dew point control - Burners for liquid and solid fuels - burner management - soot blowing operation

UNIT IV **9 Hours**

BOILER CONTROL LOOPS II

Boiler feed water processing and control - Types of boilers like FBC, CFBC, Fluidized Bed - drum level control - steam temperature and pressure control - Super heater control - deaerator control – furnace safety interlocks and boiler interlocks -. boiler efficiency calculation

UNIT V **9 Hours**

NUCLEAR POWER PLANT INSTRUMENTATION AND TURBINE CONTROL

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics - safety instrumentation, reliability aspects. Turbine-control: Types of steam turbines - governing system - Speed and load control - Vibration and shell temperature control - lubricant oil temperature control - cooling system

Total: 45 Hours

Reference(s)

1. Krishnaswamy.K and Ponnibala.M., Power Plant Instrumentation, PHI Learning Pvt.Ltd., New Delhi, 2011.
2. Swapan Basu and Ajay Kumar, Power Plant Instrumentation and Control, Elsevier, 2015.
3. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
4. Liptak B.G., Instrumentation in Process Industries, Chilton Book Company, 2013.
5. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
6. David Lindsley, Power Plant control and Instrumentation, Institution of Electrical Engineers, London, 2000.

22EI019 INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES

3 0 0 3

Course Objectives

- To provide exposure to various techniques and methods that occurs in the various regions of food analysis.
- To get an adequate knowledge about various techniques for analysis of food substances.
- To understand the concepts of electrodes and biosensors that has potential applications in food and beverage industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the role of moisture content in food processing and analyze the measurement techniques for turbidity and humidity.
2. Apply the classification of enzyme sensors, biosensors, and electronic noses in food manufacturing and analyze their working principles.
3. Apply the concepts of automatic controllers and indicators in food industries and analyze their effectiveness in maintaining process control.
4. Implement chromatography and mass spectrometry for food product analysis and analyze their accuracy and reliability.
5. Execute analytical instruments such as Scanning Electron Microscopy and Tandem Electron Microscopy and analyze their applications in food quality assessment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	1	-	1	-	-	-	-	-	1	1
2	1	2	3	3	3	-	1	-	-	-	-	-	2	2
3	1	2	3	3	3	-	2	-	-	-	-	-	2	2
4	1	2	3	3	3	-	3	-	-	-	-	-	3	3
5	1	2	3	3	3	-	2	-	-	-	-	-	3	3

UNIT I **9 Hours**

MOISTURE, TURBIDITY AND HUMIDITY MEASUREMENTS

Role of moisture content in food - wet and dry method - IR technique. Humidity - Definitions - role in food processing - classical types - wet and dry bulb hygrometer - Electronic methods. Turbidity and colour: Definition and role, standards and units, basic turbidity meter, light scattering and absorbtion type

UNIT II **9 Hours**

FOOD ENZYMES AND FLAVOUR

Food enzymes and flavour : Human olfaction - Importance of enzyme sensors - biosensors -sensing arrays - Electronics Nose.

UNIT III **9 Hours**

CONTROLLERS AND INDICATORS

Basic control concept - Temperature controller in dryer - ration control in food pickling -atmospheric controller in food preservation.

UNIT IV **9 Hours**

CHROMATOGRAPHY AND MASS SPECTROMETRY IN FOOD INDUSTRY

Basics of gas and liquid chromatography - GC and HPLC Application in food analysis - MS application in food analysis

UNIT V **9 Hours**

AUTOMATION IN FOOD INDUSTRY

Sorting-Food chilling and freezing-Fruits and vegetable processing-Packing of food products-Robotics in food industry

Total: 45 Hours

Reference(s)

1. 1. Nielsen, S.S, Introduction to the chemical analysis of foods- Jones and Bartlett Publishers, Boston, London, 2004.
2. Mahindru,S.N, -Food additives. Characteristics, detection and estimation-. Tata McGraw Hill Publishing Company Limited, New Delhi, 2000.
3. B.G.Liptak, ed -Instrument Engineers Handbook: Process Measurement and Analysis-, Butterworth & Heinemann, 1995.
4. R G. Moreira, T.P Coultate Automatic Control for Food Processing System, 2001.
5. Gouri S Mittal, Computerized control system in the food industry, Marcel Decker Inc. 1997.

22EI020 SEMICONDUCTOR MANUFACTURING 3 0 0 3

Course Objectives

- To characterize the materials based on band gap
- To study the light semiconductor interactions
- To analyze the band gap and defects concentration in fabrication process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits

Course Outcomes (COs)

1. Outline the band origination in chemical bonding and electrical conductivity
2. Differentiate the materials types based on their band gap values and use this knowledge as per their requirements.
3. Attribute the junctions formed in PN diode and its theory.
4. Contrast the solar cell and its working with advantages.
5. Examine the band gap, reflection and transmission percentage of a grown film over substrate with contents of defects.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	1	1	-	-	-	-	-	-	-	-	1	-
2	1	2	1	2	-	-	-	-	-	-	-	-	1	-
3	1	3	1	2	-	-	-	-	-	-	-	-	1	-
4	2	3	1	3	-	-	-	-	-	-	-	-	1	-
5	2	2	1	3	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

ELECTRONIC MATERIALS

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.

UNIT II **9 Hours**

SEMICONDUCTORS

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

UNIT III **9 Hours**

LIGHT-SEMICONDUCTOR INTERACTION

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi"s golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

UNIT IV **9 Hours**

MEASUREMENTS

Four-point probe and van der Pauw method for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission

UNIT V **9 Hours**

MANUFACTURING AND APPLICATIONS

Semiconductor manufacturing: raw materials, Step-by-step process: Cleaning, Film Deposition, Post-deposition Cleaning, Resist Coating, Exposure, Development, Etching & Implantation of Impurities. Quantum wells, wires, and dots: design, fabrication, and characterization techniques. Hetero-junctions and associated band-diagrams

Total: 45 Hours

Reference(s)

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill, 1995.
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2007.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley, 2008.
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York, 2007.
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India, 1997.
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Guptaon NPTEL.

22EI021 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To understand the fundamentals of the Automotive systems
- To gain knowledge in digital engine control, automotive networking, and diagnostics
- To analyse standards, impacts, and economy of electric vehicles

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the basics of automobile dynamics and design electronics.
2. Analyze automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
3. Use available automotive sensors and actuators while interfacing with microcontrollers/ microprocessors during automotive system design.
4. Implement the networking of various modules in automotive systems, communication protocols, and diagnostics of the sub-systems
5. Analyze standards, impact and economy of Electric Vehicles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	1	-
2	3	2	2	1	-	-	-	-	-	-	-	-	1	-
3	3	2	2	1	-	-	-	-	-	-	-	-	1	-
4	3	3	2	1	-	-	-	-	-	-	-	-	1	-
5	3	3	2	2	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

AUTOMOTIVE FUNDAMENTALS OVERVIEW

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System- Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery --Operating principle.

UNIT II **9 Hours**

AUTOMOTIVE SENSORS

Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor.

UNIT III **9 Hours**

DIGITAL ENGINE CONTROL SYSTEMS

Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics

UNIT IV **9 Hours**

AUTOMOTIVE NETWORKING AND DIAGNOSTICS

Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces, Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics.

UNIT V **9 Hours**

ELECTRIC VEHICLES

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - Legislation and regulation - Standardization - Energy efficiency - Assessing economy of EVs - Fuel economy - Fuel consumption - Greenhouse gas emissions

Total: 45 Hours

Reference(s)

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, John Wiley and Sons, 2012.

22EI022 GREEN ELECTRONICS 3 0 0 3

Course Objectives

- To understand the sustainable practices and principles in electronics manufacturing.
- To implement green electronic solutions, considering energy efficiency, recyclability, and reduction of hazardous materials.
- To evaluate and optimize electronic systems for sustainability, enabling the design and development of eco-friendly electronics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the principles, regulations, and standards, and their importance in green electronics.
2. Apply sustainable design and manufacturing techniques to develop energy-efficient and environmentally-friendly electronic systems
3. Analyze and evaluate the environmental impact of electronic devices
4. Implement circular economy principles into electronic product design.
5. Attribute the social and economic implications of green electronics.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	2	-
2	3	2	2	1	-	-	-	-	-	-	-	-	1	-
3	3	2	2	1	-	-	-	-	-	-	-	-	1	-
4	3	3	2	1	-	-	-	-	-	-	-	-	1	-
5	3	3	2	2	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION TO GREEN ELECTRONICS

Overview of green electronics and its significance in sustainability - Environmental impacts of electronic devices and e-waste management - Regulatory frameworks and standards for green electronics - Green design principles and life cycle assessment.

UNIT II **9 Hours**

ENERGY EFFICIENCY IN ELECTRONICS

Energy consumption analysis in electronic devices - Techniques for improving energy efficiency, such as power management and low-power design - Energy-efficient components and architectures for electronic systems - Energy harvesting and renewable energy sources for powering electronics.

UNIT III **9 Hours**

MATERIALS AND MANUFACTURING FOR GREEN ELECTRONICS

Sustainable materials selection for electronic components and packaging - Design for disassembly and recycling in electronics manufacturing - Reduction of hazardous substances in electronic products - Green manufacturing techniques, such as clean production and waste reduction.

UNIT IV **9 Hours**

DESIGN FOR CIRCULAR ECONOMY

Circular economy principles and their application to electronics - Remanufacturing and refurbishment strategies for extending product lifecycles - Reverse logistics and closed-loop supply chains for electronic products - End-of-life management and responsible disposal of electronic waste.

UNIT V **9 Hours**

GREEN ELECTRONICS CASE STUDIES

Case studies of successful green electronics initiatives and implementations - Emerging trends and technologies in green electronics, such as eco-design software and sustainable packaging - Social and economic implications of green electronics

Total: 45 Hours

Reference(s)

1. Mohamad K. Hasan Green Electronics: Design and Manufacturing, 2008.
2. Ali Emadi and Mehrdad Ehsani, Energy-Efficient Electronics: Principles and Practice, 2016.
3. Casey B. Chiu, Sustainable Electronics: Design for Energy Efficiency and Environmental Responsibility, 2016.
4. Martin Charter Design for the Circular Economy: Second Edition, 2017.
5. John R. Okyere. Green Electronics: Green Bottom Line Impact on Sustainable Product Design and Profitability, 1999.

22EI023 DIGITAL VLSI **3 0 0 3**

Course Objectives

- To learn the fundamentals of VLSI design with the IC Manufacturing Process
- To familiarize with VLSI combinational logic circuits design
- To familiarize with VLSI sequential logic circuits design
- To learn the various arithmetic circuits and testing methodologies
- To familiarize with the different FPGA architectures

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze MOS devices and inverter.
2. Design and analyze combinational logic.
3. Design and analyze Sequential logic.
4. Design and analyze data path cells.
5. Design digital logic using FPGA.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	1	-	-	-	-	-	-	-	-	-	-
2	3	2	3	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	-	-	-	-	-	-	-	-	-	-
4	1	3	3	1	-	-	-	-	-	-	-	-	-	-
5	3	3	3	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

MOS TRANSISTOR PRINCIPLES

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits and Device modelling. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore"s constant, Logical Effort. Case study: Study of technology development in MOS.

UNIT II **9 Hours**

COMBINATIONAL LOGIC CIRCUITS

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic. Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NORA logic.

UNIT III **9 Hours**

SEQUENTIAL LOGIC CIRCUITS

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.

UNIT IV **9 Hours**

DESIGNING ARITHMETIC BUILDING BLOCKS

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing-Manufacturing test principles- Design for testability. Case study: Analysis of area, power and delay for 16 bit adder and 8 bit multiplier.

UNIT V **9 Hours**

IMPLEMENTATION STRATEGIES

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)

Total: 45 Hours

Reference(s)

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, Digital Integrated circuits: A Design Perspective, Prentice Hall of India, 2nd Edition, 2003.
2. N.Weste, K.Eshraghian, Principles of CMOS VLSI DESIGN, A system Perspective, 2nd Edition, Addision Wesley, 2004.
3. A.Pucknell, Kamran Eshraghian, BASIC VLSI DESIGN, Prentice Hall of India, 3rd Edition, 2007.
4. M.J. Smith, Application Specific Integrated Circuits, Addisson Wesley, 1997.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, CMOS Circuit Design, Layout and Simulation, Prentice Hall of India, 2005.

22EI024 REAL TIME EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

- To provide in depth knowledge about embedded processor, its hardware and software
- To understand the embedded system design and their operating system
- To apply knowledge of embedded processor architecture in various applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the architecture and the functionality of ARM Microprocessor
2. Demonstrate the architecture and the functionality of computing devices
3. Outline the basic concepts of operating system
4. Implement an interfacing of networks with Microprocessor/ Microcontroller
5. Design a real time application for various domain using embedded system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	2	-	-	-	-	-	-	-	-	-	-	-
4	2	1	2	-	-	-	-	-	-	-	-	-	2	2
5	2	2	-	-	-	-	-	-	-	-	-	-	2	1

UNIT I **9 Hours**

INTRODUCTION TO ARM PROCEESORS

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT II **9 Hours**

COMPUTING PLATFORM AND DESIGN ANALYSIS

CPU buses - Memory devices - I/O devices - Memory Protection Units - Memory Management Units - Component interfacing - Design with microprocessors - Development and Debugging - Program design - Model of programs - Assembly and Linking - Basic compilation techniques - Analysis and optimization of execution time, power, energy, program size - Program validation and testing.

UNIT III **9 Hours**

PROCESS AND OPERATING SYSTEMS

Multiple tasks and multi processes - Processes - Context Switching - Scheduling policies - Multiprocessor - Inter Process Communication mechanisms - Evaluating operating system performance - Power optimization strategies for processes - Firmware and Operating Systems for ARM processor.

UNIT IV **9 Hours**

HARDWARE ACCELERATES

Accelerators - Accelerated system design-Distributed Embedded Architecture - Networks for Embedded Systems - Network based design - Internet enabled systems.

UNIT V **9 Hours**

CASE STUDY

Hardware and software co-design - Data Compressor - Software Modem - Personal Digital Assistants - Set-Top-Box, System-on-Silicon - FOSS Tools for embedded system development.

Total: 45 Hours

Reference(s)

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide Designing and Optimizing System Software, Morgan Kaufmann publishers, 2004.
2. David E-Simon, An Embedded Software Primer, Pearson Education, 2007.
3. K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, Dreamtech Press, 2005.
4. Tim Wilmshurst, An Introduction to the Design of Small Scale Embedded Systems, Pal grave Publisher, 2004.
5. Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.

22EI025 SOLAR PV FUNDAMENTAL AND APPLICATIONS

3 0 0 3

Course Objectives

- To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.
- To understand the construction details and principle of operations of solar photovoltaic system
- To learn the economic and environmental merits of solar energy for variety applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the radiation principles with respective solar energy estimation.
2. Apply the PV technology principles and techniques of various solar cells / materials for lister energy conversion.
3. Apply economic and environmental merits of solar energy for variety applications
4. Analyze the constructional details of solar photovoltaic system and its applications
5. Design the applications of solar energy sources to enhance the passive architecture.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	1	-	1	-	-	-	-	-	-	-
2	2	2	2	1	2	-	2	-	-	-	-	-	-	-
3	2	1	2	2	1	-	2	-	-	-	-	-	-	-
4	1	2	1	1	1	-	2	-	-	-	-	-	-	-
5	2	2	2	1	2	-	1	-	-	-	-	-	-	-

UNIT I **9 Hours**

SOLAR RADIATION AND COLLECTORS

Solar angles-day length, angle of incidence on tilted surface-Sunpath diagrams-shadow determination-extraterrestrial characteristics-measurement and estimation on horizontal and tilted surfaces-flat plate collector thermal analysis-heat capacity effect-testing methods-evacuated tubular collectors-concentrator collectors-classification-design and performance parameters-tracking systems-compound parabolic concentrators-parabolic trough concentrators-concentrators with point focus-Heliostats-performance of the collectors.

UNIT II **9 Hours**

APPLICATIONS OF SOLAR THERMAL TECHNOLOGY

Principle of working, types-design and operation of-solar heating and cooling systems-solar water heaters-thermal storage systems-solar still-solar cooker-domestic, community-solar pond-solar drying.

UNIT III **9 Hours**

SOLAR PV FUNDAMENTALS

Semiconductor-properties-energy levels-basic equations of semiconductor devices physics. Solar cells-p-n junction: homo and hetro junctions-metal semiconductor interface-dark and illumination characteristics-figure of merits of solar cell -efficiency limits-variation of efficiency with band-gap and temperature-efficiency measurements-high efficiency cells-preparation of metallurgical, electronic and solar grade Silicon-production of single crystal Silicon: Czokralski (CZ) and Float Zone(FZ) method-Design of a complete silicon-GaAs-InP solar cell-high efficiency III-V, II-VI multijunction solar cell; a-Si-H based solar cells quantum well solar cell-thermo-photovoltaic.

UNIT IV **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS

Solar cell array system analysis and performance prediction- Shadow analysis: reliability-solar cell array design concepts-PV system design-design process and optimization-detailed array design-storage autonomy-voltage regulation-maximum tracking-use of computers in array design-quick sizing method-array protection and troubleshooting-centralized and decentralized SPV systems-standalone-hybrid and grid connected system-System installation-operation and maintenances-field experience-PV market analysis and economics of SPV systems.

UNIT V **9 Hours**

SOLAR PASSIVE ARCHITECTURE

Thermal comfort-heat transmission in buildings-bioclimatic classification-passive heating concepts: direct heat gain-indirect heat gain-isolated gain and sunspaces-passive cooling concepts: evaporative cooling-radiative cooling-application of wind, water and earth for cooling; shading-paints and cavity walls for cooling-roof radiation traps-earth air-tunnel. energy efficient landscape design-thermal comfort-concept of solar temperature and its significance-calculation of instantaneous heat gain through building envelope.

Total: 45 Hours

Reference(s)

1. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Alan L Fahrenbruch and Richard H Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, 1983.
4. Larry D Partain, Solar Cells and their Applications, John Wiley and Sons, Inc, 1995.
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.

6. Sodha, M.S, Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S. Solar Passive Building, Science and Design, Pergamon Press, 1986.
7. Krieder, J and Rabi, A., Heating and Cooling of Buildings: Design for Efficiency, McGraw- Hill, 1994.

22EI026 PROCESS MODELING AND SIMULATION 3 0 0 3

Course Objectives

- To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.
- To obtain the mathematical model for the real time systems by applying fundamental laws
- To analyze the system performance using simulation of the model with appropriate software

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Formulate and analyze mathematical models for chemical processes by applying basic principles
2. Develop and evaluate mathematical models for chemical processes by applying fundamental conservation laws.
3. Analyze mathematical models for various chemical and physical systems, including reactors, separation units, and transport processes.
4. Implement and evaluate process simulation techniques using sequential modular and equation-oriented approaches
5. Develop and solve mathematical models for chemical processes using process simulators.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3	2	-	-	-	-	-	-	-	1	-	2
2	3	2	3	2	-	-	-	-	-	-	-	1	-	2
3	3	2	3	2	-	-	-	-	-	-	-	1	-	2
4	3	2	3	2	-	-	-	-	-	-	-	1	-	2
5	3	2	3	2	2	-	-	-	-	-	-	1	-	2

UNIT I **9 Hours**

INTRODUCTION

Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Review of numerical techniques, Model simulation.

UNIT II **9 Hours**

FUNDAMENTAL LAWS

Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibrium, bubble and dew points.

UNIT III **9 Hours**

MODELING OF SPECIFIC SYSTEMS

Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.

UNIT IV **9 Hours**

SIMULATION

Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation.

UNIT V **9 Hours**

MATHEMATICAL MODELS

Writing and solving models for simple chemical processes, use of process simulator for solving models for mixer, pump, compressor, heat exchanger, reactor, absorption/distillation column and steady state flow sheet simulation.

Total: 45 Hours

Reference(s)

1. Nagabhushan. S.Sudha.L.K, "Aircraft instrumentation and Systems", International publishing house Private limited, 2014.
2. Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill, 1993.
3. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995.
4. Treager, S., "Gas Turbine Technology", McGraw Hill, 1997.

22EI027 SYSTEM IDENTIFICATION 3 0 0 3

Course Objectives

- To provide an overview system identification based on the Non-parametric methods and spectral analysis methods
- To estimate the system parameters using parametric model structures
- To study the system identification using generalized relay feedback identification
- To familiarize the student with the Identification of systems operating in closed loop as well as practical aspects.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Obtain the mathematical model of a real time system using Non-parametric and spectral analysis methods.
2. Estimate the system parameters using parametric model structures available in the system identification tool box.
3. Determine the mathematical model for stable and unstable system using relay feedback identification methods.
4. Analyze the system Parameter in the closed loop system using direct, indirect and Subspace Identification methods.
5. Explain the procedure and limitation in practical aspects of identification for an experimental setup.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	1	1	-	-	-	-	-	-	-	-	2	-
3	3	3	3	2	-	-	-	-	-	-	-	-	2	-
4	3	3	2	3	-	-	-	-	-	-	-	-	2	-
5	3	3	3	3	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INTRODUCTION

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

UNIT II **9 Hours**

PARAMETER ESTIMATION METHODS

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method- Exercises using system identification toolbox.

UNIT III **9 Hours**

RELAY FEEDBACK IDENTIFICATION

A generalized relay feedback identification method-model; structure selection-relay feedback identification of stable processes: FOPDT and SOPDT model. Relay feedback Identification of unstable processes: FOPDT and SOPDT model- Illustrative examples

UNIT IV **9 Hours**

CLOSED- LOOP IDENTIFICATION

Identification of systems operating in closed loop: Identifiability considerations-direct identification-indirect identification-Subspace Identification methods: classical and innovation forms, free and structures parameterizations

UNIT V **9 Hours**

PRACTICAL ASPECTS OF IDENTIFICATION

Practical aspects: experimental design-input design for identification, notion for persistent excitation, drifts and de-trending-outliers and missing data-pre-filtering-robustness -Model validation and Model structure determination-case studies. Introduction to Nonlinear System Identification

Total: 45 Hours

Reference(s)

1. Arun K. Tangirala "Principles of System Identification Theory and Practice", CRC Press, 2018.
2. Karel J. Keesman, "System Identification an Introduction", Springer, 2011.
3. LennartLjung, "System Identification: Theory for the user", Second edition, Prentice Hall, 1999.
4. Tao Liu, FurongGao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verilog London Ltd, 2012.

22EI028 NON LINEAR CONTROL 3 0 0 3

Course Objectives

- To impart knowledge on phase plane analysis of non-linear systems
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov's theory.
- To introduce the concept of sliding mode control.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the nonlinear systems using phase plane methods.
2. Investigate the nonlinearities of the system using describing function and limit cycle methods.
3. Determine the stability of the given nonlinear system using Lyapunov methods.
4. Apply the linearization concepts in feedback for stabilize the nonlinear MIMO and SISO systems.
5. Design the sliding mode controller for a given nonlinear MIMO system with simulation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	3	3	-	-	-	-	-	-	2	-	1
2	3	3	1	3	3	-	-	-	-	-	-	2	-	1
3	3	3	2	-	-	-	-	-	-	-	-	2	-	2
4	3	3	3	3	3	3	2	-	-	-	-	2	-	3
5	3	3	3	3	3	3	2	-	-	-	-	2	-	3

UNIT I **9 Hours**

PHASE PLANE ANALYSIS

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits- Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems - simulation of phase portraits in MATLAB.

UNIT II **9 Hours**

DESCRIBING FUNCTION

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions- Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. Simulation of limit cycles in MATLAB.

UNIT III **9 Hours**

LYAPUNOV THEORY

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunovs Direct Method-Positive definite Functions and Lyapunov Functions Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunovs Direct Method-Krasovskis Method-Variable Gradient Method-Physically-Control Design based on Lyapunovs Direct Method.

UNIT IV **9 Hours**

FEEDBACK LINEARIZATION

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation- Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum- Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in MATLAB.

UNIT V **9 Hours**

SLIDING MODE CONTROL

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in MATLAB.

Total: 45 Hours

Reference(s)

1. Ramirez, W.; "Computational Methods in Process Simulation", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control", 2nd Edn, McGraw-Hill Book Co., 1990.
3. J A E Slotine and W Li, "Applied Nonlinear control", PHI, 1991.
4. Hasan Khalil, "Nonlinear systems and control", Prentice Hall.
5. S H Zak, "Systems and control", Oxford University Press, 2003.
6. Torkel Glad and Lennart Ljung, "Control Theory-Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
7. G. J. Thaler, “Automatic control systems”, Jaico publishers, 1993.
8. Felix L. Chernousko, Igor M.Ananievski, Sergey A.Reshmin, “Control of Nonlinear Dynamical Systems Methods and Applications, Springer, First Indian Reprint, 2013.

22EI029 ADAPTIVE CONTROL 3 0 0 3

Course Objectives

- To introduce the need for and effects of adaptive control.
- To illustrate study the parameter identification of systems.
- To illustrate the self-tuning of PID controllers based on parameter identification.
- To illustrate the model reference adaptive control.
- To introduce practical application through case studies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1.Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the principle of adaptive control schemes to implement in a system with a suitable adaptive control system to eliminate the effect of parameter variation and control.
2. Apply the identified model based on parametric identification methods for controller design/tuning.
3. Design the Deterministic and Stochastic Self Tuning Regulators for a given system.
4. Design of model reference adaptive controller for a given system.
5. Design gain scheduling controller and apply adaptive control schemes for industrial processes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	-	-	-	-	-	-	-	-	2	-	2
2	3	3	2	-	-	-	-	-	-	-	-	2	1	2
3	3	3	3	1	-	1	-	-	-	-	-	2		3
4	3	3	3	1	-	1	-	-	-	-	-	2		3
5	3	3	3	1	-	1	-	-	-	-	-	2		3

UNIT I **9 Hours**

INTRODUCTION

Introduction to adaptive Control-Effects of process Variations-Adaptive Control Schemes-Adaptive Control Problem-Non-Parametric Identification-Step Response Method-Impulse Response Method-Frequency response method.

UNIT II **9 Hours**

PARAMETRIC IDENTIFICATION

Linear in parameter models-ARX-ARMAX-ARIMAX-Least square estimation-Recursive least square estimation-Extended least square estimation-Maximum likelihood estimation-Introduction to non-linear systems identification-Pseudo random binary sequence.

UNIT III **9 Hours**

SELF-TUNING REGULATOR

Deterministic in-direct self-tuning regulators-Deterministic direct self-tuning regulators-Introduction to stochastic self-tuning regulators-Stochastic indirect self-tuning regulator.

UNIT IV **9 Hours**

MODEL REFERENCE ADAPTIVE CONTROLLER

The MIT rule-Lyapunov theory-Design of model reference adaptive controller using MIT rule and Lyapunov theory-Relation between model reference adaptive controller and self-tuning regulator.

UNIT V **9 Hours**

TUNING OF CONTROLLERS AND CASE STUDIES

Design of gain scheduling controller-Auto-tuning of PID regulator-Stability analysis of adaptive controllers-Application of adaptive control in chemical reactor, distillation column and variable area tank system.

Total: 45 Hours

Reference(s)

1. Karl J. Astrom & Bjorn Wittenmark, "Adaptive Control", Pearson Education (Singapore), Second Edition, 2003.
2. Shankar Sastry and Marc Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 1994.
3. I. D. Landau, R. Lozano, and M. M Saad, "Adaptive Control", NY: Springer-Verlag, 1998.
4. Gang Tao, "Adaptive Control Design and Analysis", Wiley-IEEE Press, 2003.
5. Kumpati S. Narendra, Anuradha M. Annaswamy, "Stable Adaptive Control Systems", Prentice Hall, 1989.
6. Chalam, "Adaptive Control Systems: Techniques and Applications", CRC Press, 1987.
7. T. C.H.A. Hsia, 'System Identification', Lexington books, 1974.
8. Stephanopoulis G. 'Chemical Process Control', Prentice Hall of India, New Delhi, 1990.

22EI030 DIGITAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- To give basic knowledge in digital control system
- To impart necessary knowledge in stability analysis for discrete system
- To model systems in state space representation
- To provide a solution to state equations and to study various computational algorithms
- To know about the compensators in digital controllers

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the sampling theorem for discrete time analysis and reconstruction for an analog signal.
2. Determine the response of a discrete time system and Investigate the stability of the discrete time system
3. Design a digital compensator / controller using frequency and time domain technique.
4. Formulate the state space model and compute the solutions of discrete time state space equation.
5. Design the state feedback controller / observer for a discrete time control system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	2	3	-
2	3	2	1	1	-	-	-	-	-	-	-	2	-	2
3	3	3	3	1	-	1	-	-	-	-	-	2	-	3
4	3	3	3	1	-	-	-	-	-	-	-	2	-	3
5	3	3	3	1	-	1	-	-	-	-	-	2	-	3

UNIT I **8 Hours**

INTRODUCTION TO DIGITAL CONTROL

Introduction - components and configuration of digital control system - discrete time system representation - sampling theorem - Mathematical modelling of sampling process - zero order hold - first order hold - Data reconstruction.

UNIT II **10 Hours**

MODELING AND STABILITY ANALYSIS DISCRETE-TIME SYSTEMS

Revisiting Z transform - Modified Z transform - Mapping of splane to z plane - Pulse transfer function - Pulse transfer function of closed loop system - Jury stability test - Transient and steady state responses.

UNIT III **11 Hours**

DESIGN OF SAMPLED DATA CONTROL SYSTEMS

Root locus method - Bode plot - Lead, lag and lag-lead compensator design using time, frequency domain - Discrete PID Controller - Design of digital control systems with deadbeat response.

UNIT IV **8 Hours**

DISCRETE STATE SPACE MODEL

Introduction to state variable model - Various canonical forms - Characteristic equation, state transition matrix - Solution to discrete state equation - Controllability and observability.

UNIT V **8 Hours**

STATE FEEDBACK DESIGN

Pole placement by state feedback - Set point tracking -controller - Full order observer - Reduced order observer.

Total: 45 Hours

Reference(s)

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2012.
2. K. Ogata, Discrete time control system, Pearson Education Asia, New Delhi, 2011.
3. B.C.Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010.
4. I.J. Nagarath and M. Gopal, Control System Engineering, New age International Pvt. Ltd, New Delhi, 2011.
5. Lawrence J. Kamm, Understanding Electro Mechanical Engineering: An Introduction to Mechatronics, Prentice Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, Mechatronics, Tata McGraw-Hill publishing Company Ltd, 2009.

22EI031 OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN

3 0 0 3

Course Objectives

- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Translate descriptive statements of the design engineering problems in to a mathematical statement of optimization.
2. Apply the concept of calculus of variation and principal of optimality for solving problems
3. Design of Non-linear optimization controller & Design and Tuning a PID controller via optimization technique.
4. Apply the concept of Linear Quadratic method for solving problems
5. Design of optimal low-order feedforward controllers & model based optimization of a Controller

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1	-	-	-	-	-	-	-	2	-	2
2	3	3	3	1	-	-	-	-	-	-	-	2	-	3
3	3	3	3	1	-	1	-	-	-	-	-	2	-	3
4	3	3	3	1	-	-	-	-	-	-	-	2	-	3
5	3	3	3	1	-	1	-	-	-	-	-	2	-	3

UNIT I **8 Hours**

INTRODUCTION TO OPTIMIZATION

Engineering application of Optimization-Statement of an Optimization Problem-Optimal Problem Formulation-Classification of Optimization problem. Optimum design concepts: Definition of Global and Local Optima-Optimality Criteria-Review of basic calculus Concepts-Global optimality.

UNIT II **10 Hours**

CALCULUS OF VARIATION AND HAMILTON FORMULATION

Fundamental concepts – Extremum functionals involving single and several independent functions – Piecewise smooth extremals - Variation of functionals with fixed and free terminal time constrained extrema Pontryagin's minimum principle - State inequality constraints – The Weierstrass Erdmann corner conditions - Solution of Bolza problem. Partial differential equation for cost function – Hamilton Jacobi equation - Principle of optimality, solution of Hamilton Jacobi equation - Matrix Riccati equation - Optimal control law.

UNIT III **10 Hours**

PID DESIGN BY OPTIMIZATION

Unconstrained, Constrained, Lagrange Multipliers, Quadratic Programming, Merit Functions, Line Search, Trust Region Methods, SQP-Introduction, PID Design, Convex-concave Optimization, MIMO PID Tuning via Iterated LMI Restriction, Model and Assumptions, Design Problem, Quadratic Matrix Inequality Form, Linear Matrix Inequality Restriction.

UNIT IV **9 Hours**

LINEAR QUADRATIC CONTROL PROBLEMS

Optimal control by Liapunov method - Parameter optimization – Quadratic performance index -Optimal control of systems - Matrix Riccati equation and solution methods of State regulator and discrete systems - Choice of weighting matrices – Linear Quadratic Guassian control – Kalman filter – H2 and H∞ Control and Optimal estimation

UNIT V **8 Hours**

DESIGN OF OPTIMAL LOW-ORDER FEEDFORWARD CONTROLLERS

Feedforward Structure, Optimal Feedforward Control, Optimal Feedforward Controller Characteristics, Control Signal Considerations, Precompensation, Design Examples. Feedforward controller design using convex optimization and tuning rules for proportional set-point weighting. Plant Models, Controllers and Signals, Error Minimization, Feedforward and Feedback Design, Tuning Rules for Set-Point Weighting.

Total: 45 Hours

Reference(s)

1. Rao S.S.Engineering Optimization, Theory and Practice New Age International Publishers, 4th Edition, 2012.
2. Design of Low-Order Controllers using Optimization Techniques Hast, Martin, 2015.
3. Deb K.Optimization for Engineering Design Algorithms and Examples, PHI, 2000.
4. Arora J.Introduction to Optimization Design-Elsevier Academic Press, New Delhi, 2004.
5. Saravanan R.Manufacturing Optimization through Intelligent Techniques-Taylor & Francis (CRC Press), 2006.
6. Hardley G.Linear Programming-Narosa Book Distributors Private Ltd., 2002.

22EI032 APPLIED SOFT COMPUTING **3 0 0 3**

Course Objectives

- To expose the concepts of feedforward and feedback neural networks.
- To provide adequate about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the necessity of soft computing techniques.
2. Analyze the functions and application of Artificial Neural Network
3. Apply the concept of fuzziness involved in various systems
4. Analyze the working of Genetic Algorithm
5. Design the soft computing techniques for linear and nonlinear systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	2	1	-	-	-	-	-	-	-	-	-
2	2	2	1	2	1	-	-	-	-	-	-	-	-	2
3	2	2	1	2	1	-	-	-	-	-	-	-	-	1
4	2	2	1	2	1	-	-	-	-	-	-	-	-	1
5	2	2	1	2	1	-	-	-	-	-	-	-	-	1

UNIT I **9 Hours**

INTRODUCTION TO SOFT COMPUTING

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient –back propagation algorithm- factors affecting back propagation training- applications.

UNIT II **9 Hours**

ARTIFICIAL NEURAL NETWORKS

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory- and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III **9 Hours**

FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets-basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control-Fuzzification-inference and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV **9 Hours**

GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters-Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

UNIT V **9 Hours**

APPLICATIONS

GA application to power system optimization problem- Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural Network interconnection systems- Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox-Stability analysis of fuzzy control systems.

Total: 45 Hours

Reference(s)

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.

22EI033 MACHINE LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To Apply the Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environment that is suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Design machine learning systems and evaluation.
2. Apply probabilistic discriminative and generative algorithms for regression and classification problems and analyze the results
3. Apply an unsupervised algorithm to predict the continuous and categorical data and analyze the results.
4. Apply the machine learning algorithms for to solve real-world problems.
5. Generate machine learning model for regression and classification problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	3	-	-	-	-	-	-	-	-	-	-	-
2	1	2	3	3	2	-	-	-	-	-	-	-	-	-
3	1	2	3	3	2	-	-	-	-	-	-	-	-	1
4	2	2	2	3	3	-	-	-	-	-	-	-	-	1
5	1	1	2	3	3	-	-	-	-	-	-	-	-	-

UNIT I **7 Hours**

INTRODUCTION

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, - hypothesis space and inductive bias, evaluation, cross-validation.

UNIT II **10 Hours**

SUPERVISED LEARNING

Regression-Linear and multilinear regression, polynomial, decision trees, random forest. Classification- k-nearest neighbor algorithm, Classification and Regression Tree, logistic regression, SVM.

UNIT III **10 Hours**

UNSUPERVISED LEARNING

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

UNIT IV **9 Hours**

NEURAL NETWORKS

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

UNIT V **9 Hours**

APPLICATION

Machine Learning Frame works- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

Total: 45 Hours

Reference(s)

1. Stephen Marsland, Machine Learning - An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition, Springer series in Statistics.
4. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine Learning (FOML)", MIT Press, 2012.
5. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms (UML)", Cambridge University Press, 2014.

22EI034 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real-world applications
- To analyze the performance of deep learning architectures for real time applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning
3. Apply deep learning concepts into text and image processing.
4. Design a deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	2	-	-	-	-	-	-	2	-	-
2	1	2	3	1	2	-	-	-	-	-	-	2	-	1
3	1	1	2	3	2	-	-	-	-	-	-	1	-	-
4	1	1	2	3	2	-	-	-	-	-	-	1	-	2
5	1	1	2	3	2	-	-	-	-	-	-	2	-	1

UNIT I **7 Hours**

INTRODUCTION TO MACHINE LEARNING

Learning algorithms, Maximum likelihood estimation, Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

UNIT II **9 Hours**

INTRODUCTION TO DEEP NEURAL NETWORKS

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization.

UNIT III **11 Hours**

DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering.

UNIT IV **11 Hours**

DEEP GENERATIVE MODELS

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

UNIT V **7 Hours**

DEEP REINFORCEMENT LEARNING

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

Total: 45 Hours

Reference(s)

1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner"s Approach", O"Reilly Media, 2017.
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

22EI035 PYTHON PROGRAMMING FOR AI AND ML 3 0 0 3

Course Objectives

- To study uninformed and Heuristic search techniques.
- To introduce Machine Learning and supervised learning algorithms
- To study ensembling and unsupervised learning algorithms

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the appropriate search algorithms for problem-solving
2. Apply reasoning under uncertainty for the models
3. Design of supervised learning models for the application
4. Design of ensembling and unsupervised models for the application
5. Design of deep learning neural network models for the application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	2	-	-	-	-	-	-	2	-	-
2	1	2	3	1	2	-	-	-	-	-	-	2	-	-
3	1	1	2	3	2	-	-	-	-	-	-	1	-	-
4	1	1	2	3	2	-	-	-	-	-	-	2	-	-
5	1	1	2	3	2	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

PROBLEM SOLVING

Introduction to AI-AI Applications-Problem solving agents- search algorithms-uninformed search strategies - Heuristic search strategies - Local search and optimization problems - adversarial search - constraint satisfaction problems (CSP)

UNIT II **9 Hours**

PROBABILISTIC REASONING

Acting under uncertainty - Bayesian inference- naive bayes models. Probabilistic reasoning - Bayesian networks - exact inference in BN - approximate inference in BN - causal networks

UNIT III **9 Hours**

SUPERVISED LEARNING

Introduction to machine learning - Linear Regression Models: &Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function - Probabilistic discriminative model - Logistic regression, Probabilistic generative model - Naive Bayes, Maximum margin classifier - Support vector machine, Decision Tree, Random forests

UNIT IV **9 Hours**

ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT V **9 Hours**

NEURAL NETWORKS

Perceptron- Multilayer perceptron, activation functions, network training- gradient descent optimization - stochastic gradient descent, error backpropagation, from shallow networks to deep networks- Unit saturation (aka the vanishing gradient problem) -ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

Total: 45 Hours

Reference(s)

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007.
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008.
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006.
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.
7. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997.
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

22EI036 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To familiarize with the basic concepts and models of the operations research
- To use transportation and assignment model techniques for effective decisions-making.
- To optimization that are tailored to large-scale statistics and machine learning problems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate the basics of convex optimization in linear programming
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Analyze the fundamental concepts of Genetic Algorithm.
4. Analyze the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Design the various optimization techniques involved in PSO for suitable applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	1	2	-	-	-	-	-	-	2	-	-
2	2	2	3	1	2	-	-	-	-	-	-	2	-	-
3	2	1	2	3	2	-	-	-	-	-	-	2	-	-
4	2	1	2	3	2	-	-	-	-	-	-	2	-	-
5	2	1	2	3	2	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

BASICS OF CONVEX OPTIMIZATION

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

UNIT II **9 Hours**

STOCHASTIC AND NONCONVEX OPTIMIZATION

Dual averaging, Polyak- Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

UNIT III **9 Hours**

MODERN OPTIMIZATION IN GA

Genetic algorithm-Introduction-biological background- traditional optimization and search techniques - Genetic basic concepts-operators-Encoding scheme-Fitness evaluation- crossover -mutation-genetic programming-multilevel optimization- real life problem- advances in GA

UNIT IV **9 Hours**

GENETIC PROGRAMMING

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems

UNIT V **9 Hours**

PARTICLE SWARM OPTIMIZATION

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO) - Formulations, Pseudo-code. Applications of PSO and ACO.

Total: 45 Hours

Reference(s)

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International.
2. Stephen Boyd and Lieven Vandenberghe"s book: Convex Optimization.
3. Nesterov"s old book: Introductory Lectures on Convex Optimization: A Basic Course.
4. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers.
5. Genetic algorithms in Search, Optimization, and Machine learning-D.E.Goldberg, Addison- Wesley Publishers.

22EI037 NATURAL LANGUAGE PROCESSING 3 0 0 3

Course Objectives

- Understand the representation and processing of Morphology and Part-of Speech Taggers
- Express different aspects of natural language syntax and the various methods used for processing syntax
- To know about various applications of natural language processing

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the different linguistic components and models of given sentences
2. Design a morphological analyzer for a language using finite state automata concepts
3. Design a parser by providing suitable grammar and words
4. Recognize the semantic role of the sentence and implement the semantic parsing
5. Apply the machine translation and statistical translation to extract the information from the sentence

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	1	1	1	1	-	-	-	-	2	-	-
2	3	1	1	2	2	1	1	-	-	-	-	2	-	-
3	3	1	1	2	1	1	1	-	-	-	-	2	-	-
4	3	1	1	1	2	1	1	-	-	-	-	2	-	-
5	3	1	1	2	2	1	1	-	-	-	-	2	-	-

UNIT I **8 Hours**

INTRODUCTION

Natural Language Processing tasks in syntax, semantics, and pragmatics -Issues - Applications - The role of machine learning - Probability Basics -Information theory - Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models

UNIT II **9 Hours**

MORPHOLOGY AND PART OF SPEECH TAGGING

Linguistic essentials - Lexical synta - Morphology and Finite State Transducers - Part of speech Tagging - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models - Transformation-based Models - Maximum Entropy Models, Conditional Random Fields

UNIT III **10 Hours**

SYNTAX PARSING

Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context-Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs

UNIT IV **10 Hours**

SEMANTIC ANALYSIS

Representing Meaning - Semantic Analysis - Lexical semantics - Word-sense disambiguation - Supervised - Dictionary-based and Unsupervised Approaches - Compositional semantics- Semantic Role Labelling and Semantic Parsing - Discourse Analysis.

UNIT V **8 Hours**

APPLICATIONS

Named entity recognition and relation extraction- Information Extraction (IE) using sequence labelling Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation - Question Answering- VXML Applications

Total: 45 Hours

Reference(s)

1. Daniel Jurafsky and James H. Martin "Speech and Language Processing", Second Edition, Prentice Hall, 2014.
2. Christopher D. Manning and Hinrich Schuetze, "Foundations of Statistical Natural Language Processing", MIT Press, 2014.
3. Roland R. Hausser, "Foundations of Computational Linguistics Human- Computer Communication in Natural Language", Springer, 2014.

22EI038 BIOMEDICAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To understand the role of instrumentation in bio medical engineering field
- To get ample knowledge on Electro-physiological and non-electric parameter measurement
- To understand principles of medical imaging - CT, MRI, diagnostic and therapeutic devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the human physiology and functioning systems of various organs
2. Outline the various electrodes and signal conditioning for electro physiological measurements
3. Examine the techniques for non-electrical parameter measurements like heart rate, respiration rate and blood pressure measurements
4. Outline the techniques used in medical image analysis and biotelemetry
5. Choose the appropriate assistive and therapeutic devices for illness

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	-	-	1	1	1	-	-	-	1	2	-
2	2	2	1	-	-	2	1	1	-	-	-	1	2	1
3	2	2	1	-	-	3	1	2	-	-	-	1	2	1
4	3	2	1	-	-	3	1	2	-	-	-	1	2	1
5	3	2	1	-	-	3	1	2	-	-	-	1	2	1

UNIT I **9 Hours**

HUMAN PHYSIOLOGY AND BIO POTENTIAL ELECTRODES

Cell and their structures - action and resting potential - nervous system: functional organization of the nervous system, structure of nervous system, neurons, synapse -transmitters and neural communication-cardiovascular system- Physiology of heart and lungs - Circulation and respiration.

UNIT II **9 Hours**

ELECTRO-PHYSIOLOGICAL MEASUREMENT

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Electrodes - Micro, needle and surface electrodes - electrical safety - grounding and isolation - Transducer - Selection criteria Einthoven triangle - ECG - EEG - EMG - Lead systems and recording methods - Typical waveforms

UNIT III **9 Hours**

NON - ELECTRICAL PARAMETER MEASUREMENTS

Measurement of blood pressure - Sphygmomanometer - Phonocardiogram - Body Plethysmography - pH of blood - Pulse oximeter - Spirometry

UNIT IV **9 Hours**

MEDICAL IMAGING PARAMETER MEASUREMENTS

X-RAY machine - Computer Tomography - Magnetic Resonance Imaging system - Ultrasonography-Endoscopy - Bio-Telemetry

UNIT V **9 Hours**

DIAGNOSTIC AND THERAPEUTIC DEVICES

Cardiac Pacemakers - Defibrillators - Ventilators- Heart Lung machine - Dialyser- Diathermy - Neurostimulator - Elements of audio and visual aids

Total: 45 Hours

Reference(s)

1. R.S.Khandpur, Hand Book of Bio-Medical instrumentation, Tata McGraw Hill publishing company Ltd., 2016.
2. J.G. Webster, Medical Instrumentation: Application and Design, John Wiley and Sons, New York, 2010.
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Tata McGraw Hill, 2007.
4. E. W. Golding and F. C. Widdis, Electrical measurements and measuring instruments, Ed.5, Pitman Publishing Ltd., London, 1963.
5. Joseph, A., A. Joseph, and Administer. Theory and Problems of Electric Circuits. Mc Graw Hill., 1994.
6. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication

22EI039 DIGITAL IMAGE PROCESSING 3 0 0 3

Course Objectives

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Apply the basics and fundamentals of digital image processing and 2D-transforms.
2. Analyze the techniques of smoothing, sharpening and enhancement in digital images.
3. Analyze the segmentation and features extraction techniques.
4. Execute the restoration concepts and filtering techniques.
5. Implement the image compression using lossy and lossless compression techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1	2	2	-	-	-	-	-	-	-	1	-
2	2	3	1	2	2	-	-	-	-	-	-	-	1	-
3	2	3	1	2	2	-	-	-	-	-	-	-	1	-
4	2	3	1	2	2	-	-	-	-	-	-	-	1	-
5	2	3	1	2	2	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Fundamentals of Image processing: Elements of digital image processing systems, Elements of visual perception, Image sensing and acquisition, Image sampling and quantization. Basic relationships between pixels- Two-dimensional mathematical preliminaries

UNIT II **9 Hours**

IMAGE ANALYSIS

Image Transforms: DFT, DCT, Hadamard, Haar, KLT, SVD, Wavelet Transform and Slant transform Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Homomorphic filtering, Frequency domain: Image smoothing and sharpening using frequency domain filters.

UNIT III **9 Hours**

IMAGE SEGMENTATION

Edge detection: Point, line and edge Detection, Detection of isolated points, Line detection, Edge models, Basic edge detection, Edge linking and boundary detection. Thresholding - basic global thresholding, Ots''s method, Multiple, Variable and multivariable thresholding, Region splitting and Region Merging

UNIT IV **9 Hours**

IMAGE RESTORATION AND RECOGNITION

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Constrained Least square filtering, inverse filtering, Wiener Filtering, Wiener filtering, Geometric transformations, Image Recognition: Patterns and pattern classes, Matching-Minimum Distance classifiers

UNIT V **9 Hours**

IMAGE COMPRESSION AND COLOUR IMAGE PROCESSING

Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-length coding, Lossless and Lossy predictive coding, Block transform coding, Wavelet coding, Image Compression Standards. Color image processing fundamentals: Pseudo color image processing- Basics of full color image processing.

Total: 45 Hours

Reference(s)

1. Digital Image Processing, C. Rafeal Gonzalez and E. Richard Woods, Pearson Education, Fourth Edition, 2018.
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2015.
3. Digital Image Processing, S Jayaraman, S Esakkirajan T Veerakumar, Mc Graw-Hill, 2010.
4. Digital Image Processing, K. William Pratt, John Wiley, 2007.
5. Digital Image Processing Using MATLAB, C. Rafeal Gonzalez, McGraw Hill, 2017.
6. Image Processing Theory, Algorithm and Architectures, M.A. Sid Ahmed, McGraw-Hill, 1995.

22EI040 BIO SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To study the characteristics of different bio signals
- To learn linear and non-linear filtering techniques to extract desired information
- To understand various techniques for automated classification and decision making to aid diagnosis

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Preprocess the Biosignals and spectral characteristics
2. Analyze biosignals in time domain & to estimate the spectrum.
3. Apply wavelet detection techniques for biosignal processing.
4. Classify Biosignals using neural networks and statistical classifiers
5. Extract the features using multivariate component analysis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	-
2	3	1	2	1	-	-	-	-	-	-	-	-	-	-
3	3	1	2	1	-	-	-	-	-	-	-	-	-	-
4	3	1	2	1	-	-	-	-	-	-	-	-	-	-
5	3	1	2	1	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

BIOSIGNAL AND SPECTRAL CHARACTERISTICS

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises- Filters- IIR and FIR filters- Spectrum - power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II **9 Hours**

TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

Time series analysis - linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation -Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III **9 Hours**

ADAPTIVE FILTERING AND WAVELET DETECTION

Filtering -LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG - structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV **9 Hours**

BIOSIGNAL CLASSIFICATION AND RECOGNITION

Signal classification and recognition - Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification, Application in Normal versus Ectopic ECG beats.

UNIT V **9 Hours**

TIME FREQUENCY AND MULTIVARIATE ANALYSIS

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis - Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

Total: 45 Hours

Reference(s)

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach", Pearson education Ltd., 2004.
5. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3rd Edition, 2010.

22EI041 HUMAN ASSISTIVE DEVICES 3 0 0 3

Course Objectives

- To study the role and importance of medical assist devices
- To get exposed to functioning of rehabilitation and related aspects.
- To learn concepts of the design aspects of prosthetic and orthotic devices.
- To become familiar with hearing and visual aids.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the various electro mechanical techniques that will help failing heart
2. Analyze the functioning of the hemodialysers for the clearance of urea from the blood.
3. Analyze the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
4. Analyze the various orthodic devices and prosthetic devices to overcome orthopaedic problems.
5. Implement the rehabilitation and electrical stimulation techniques used in clinical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	1	2	-	-	-	-	-	-	1	-
2	2	3	2	2	1	2	-	-	-	-	-	-	1	-
3	2	3	2	2	1	2	-	-	-	-	-	-	1	-
4	2	3	2	2	1	2	-	-	-	-	-	-	1	-
5	2	3	2	2	1	2	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

BASIC COMPONENTS OF BIOMEDICAL SYSTEMS AND CARDIAC ASSIST DEVICES

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

UNIT II **9 Hours**

HEMODIALYSERS

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters

UNIT III **9 Hours**

HEARING AND VISUAL AIDS

Common tests - audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids-principles, drawbacks in the conventional unit, DSP based hearing aids. Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually Challenged, Text to voice converter, Screen readers

UNIT IV **9 Hours**

PROSTHETIC AND ORTHODIC DEVICES

Hand and arm replacement - different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, sensory assist devices.

UNIT V **9 Hours**

REHABILITATION MEDICINE AND STIMULATORS

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device, Transcutaneous electrical nerve stimulator, bio-feedback.

Total: 45 Hours

Reference(s)

1. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006.
2. Levine S.N. (ed), "Advances in Bio-medical engineering and Medical physics", Vol. I, II, IV, inter university publications, New York, 1968.
3. Short Textbook of Prosthetics and Orthotics - R Chinnathurai- Jaypee BrothersMedical Publishers (P) Ltd, 2010.
4. R.S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2nd Edition, 2003.
5. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976.
6. Albert M.Cook and Webster J.G, “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982.

22EI042 MEDICAL IMAGING SYSTEMS 3 0 0 3

Course Objectives

- To study the medical image acquisition and reconstruction techniques
- To get exposed to functioning of radio isotopic imaging equipments.
- To learn concepts of the MRI, image acquisition and reconstruction techniques.
- To become familiar with X-ray and ultra sound imaging systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the nuclear medical imaging techniques for acquisition of images.
2. Analyze the x-ray medical imaging techniques and its imaging quality.
3. Apply the concept of Neuro Magnetic Science in MRI.
4. Analyze the principle and operation modes of Ultrasound Imaging.
5. Implement the radio isotopes and thermography for imaging techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	1	1	-	-	-	-	-	-	1	-
2	2	3	2	2	1	1	-	-	-	-	-	-	1	-
3	2	3	2	2	1	1	-	-	-	-	-	-	1	-
4	2	3	2	2	1	1	-	-	-	-	-	-	1	-
5	2	3	2	2	1	1	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

MEDICAL IMAGE FUNDAMENTALS AND ACQUISITION

Introduction to Imaging Techniques - Single crystal scintillation camera - Principles of scintillation camera - multiple crystal scintillation camera - solid state camera - rectilinear scanner. Image Reconstruction - Mathematical Preliminaries for Two and Three Dimensional Image Reconstructions - Radon Transform-Projection Theorem - central slice Theorem- Sinogram.

UNIT II **9 Hours**

X- RAY AND COMPUTED TOMOGRAPHY

Priniciples of sectional imaging- scanner configuration -data acquisition system -image formation principles - conversion of x-ray data in to scan image -2-D image reconstruction Techniques-Iteration and Fourier method- types of CT scanners.

UNIT III **9 Hours**

MAGNETIC RESONANCE IMAGING

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound andcolour flow mapping -applications of diagnostic ultra sound.

UNIT IV **9 Hours**

ULTRASOUND IN MEDICINE

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound and colour flow mapping - applications of diagnostic ultra sound.

UNIT V **9 Hours**

RADIO ISOTOPIC AND THERMAL IMAGING

Rectilinear scanners-linear scanners - SPECT - PET Gamma camera radio nuclides for imaging - emission computed CT. Physics of thermography - imaging systems - pyroelectric vidicon camera clinicalthermography - liquid crystal thermography

Total: 45 Hours

Reference(s)

1. Steve Webb, "The physics of medical imaging", Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
2. Jerry L.Prince and Jnathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2006.
3. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics: A John Wiley & sons, Inc., Publication, Fourth Edition, 2002.
4. Z.H. Cho., J-oie, P. Jones and Manbir Singh, Foundations of Medical Imaging: John Wiley and sons Inc. 2003.
5. P.Raghunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine" Concepts and Techniques, Orient Longman, 2007.

22EI043 BRAIN COMPUTER INTERFACE 3 0 0 3

Course Objectives

- To study the basic concepts of brain computer interface
- To get exposed to various signal acquisition methods
- To learn concepts of the signal processing methods used in brain computer interface.
- To become familiar with various machine learning methods of BCI.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the various brain computer interface types and monitoring hardware.
2. Analyze the functioning of the activation patterns and brain stimulations.
3. Execute the various feature extraction methods
4. Analyze the machine learning methods for brain computer interface.
5. Implement the brain computer interface models in various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	2	-	2	-	-	-	-	-	-	1	-
2	2	2	2	2	-	2	-	-	-	-	-	-	1	-
3	2	2	2	2	-	2	-	-	-	-	-	-	1	-
4	2	2	2	2	-	2	-	-	-	-	-	-	1	-
5	2	2	2	2	-	2	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION TO BRAIN COMPUTER INTERFACE

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT II **9 Hours**

BRAIN ACTIVATION

Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials -P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III **9 Hours**

FEATURE EXTRACTION METHODS

Data Processing - Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction, Phase synchronization and coherence

UNIT IV **9 Hours**

MACHINE LEARNING METHODS FOR BRAIN COMPUTER INTERFACE

Classification techniques - Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF""s, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT V **9 Hours**

APPLICATIONS OF BRAIN COMPUTER INTERFACE

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

Total: 45 Hours

Reference(s)

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First Edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, 2012.
3. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.
4. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch, " A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, 2007.
5. Ella Hassianien A A, Azar.A.T (Editors), “Brain-Computer Interfaces Current Trends and Applications”, Springer, 2015.

22EI044 HYDRAULICS AND PNEUMATICS 3 0 0 3

Course Objectives

- To learn hydraulic fluid / Pneumatic air fundamentals including generation and distribution
- To understand working principles, operation of hydraulic and pneumatic components
- To expose to various techniques of circuit building in pneumatics

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Attribute the fundamentals of hydraulic and pneumatic systems.
2. Differentiate the various hydraulic system components, pumps and actuators.
3. Outline the selection criteria for hydraulic system.
4. Choose the appropriate pneumatic system components for the given application.
5. Design of pneumatic circuit for simple applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	1
2	1	3	2	-	-	-	-	-	-	-	-	-	-	2
3	1	1	3	2	-	-	-	-	-	-	-	-	-	3
4	1	1	3	2	-	-	-	-	-	-	-	-	-	3
5	1	1	3	2	-	-	-	-	-	-	-	-	-	3

UNIT I **5 Hours**

FUNDAMENTALS OF HYDRAULICS AND PNEUMATICS

Introduction to fluid power, properties - hydraulic fluids, air. Selection of hydraulic fluids, comparison between hydraulics and pneumatics.

UNIT II **10 Hours**

ELEMENTS OF HYDRAULIC SYSTEMS

Pumps - types, characteristics. Valves for control of direction, flow and pressure - types, typical construction details, Actuators -types and constructional details.

UNIT III **10 Hours**

HYDRAULIC SYSTEM DESIGN

Power pack elements, design. Pipes- material, pipe fittings. seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system.

UNIT IV **10 Hours**

ELEMENTS OF PNEUMATIC SYSTEMS

Components, constructional details, filter, lubricator, regulator, constructional features, types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipment.

UNIT V **10 Hours**

PNEUMATIC CONTROL SYSTEM DESIGN

General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method, Karnaugh-Veitchmapping.

Total: 45 Hours

Reference(s)

1. Anthony Esposito,Fluid Power with Application, Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2003.
2. Srinivasan R, Hydraulic and Pneumatic Controls, McGraw Hill education (India) Pvt. Ltd, 2010.
3. MajumdarSR,Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 2003.
4. Majumda SR,Pneumatic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 1996.
5. Peter Rohner, Fluid Power Logic Circuit Design Analysis, Design, Method and WorkedExamples, The Macmillan Press Ltd., UK 1979.
6. Werner Deppert and Kurt Stoll, Pneumatic Controls: An Introduction to Principles, Vogel-Druck Wurzburg, Germany, 1975.

22EI045 SMART AND WIRELESS INSTRUMENTATION 3 0 0 3

Course Objectives

- To acquire knowledge on smart instrumentation system with their communication protocol
- To know about wireless sensor networks used in various process industries
- To get adequate knowledge on design, development and challenges in smart and wireless technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the functioning elements of a smart sensor and its standards for sensor interfacing
2. Analyze the concepts of smart instrumentation with its HART communication protocol
3. Choose the appropriate wireless instruments for the given applications
4. Attribute industrial wireless technology for process monitoring applications
5. Predict the challenges and opportunities of recent techniques in smart and wireless systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	-	-	-	-	1	-	-	-	-	1	-
2	2	2	2	-	-	-	-	1	-	-	-	-	2	-
3	3	3	3	-	-	-	-	1	-	-	-	-	2	-
4	1	2	2	-	-	-	-	1	-	-	-	-	1	-
5	2	3	1	-	-	-	-	1	-	-	-	-	2	-

UNIT I 9 Hours

SMART SENSORS

Functional elements of smart sensors: Primary and Secondary sensors - Amplifiers - Filters - Converters - Compensators - Information coding / processing - Data communication - Standards for smart sensor interface Applications.

UNIT II **9 Hours**

SMART INSTRUMENTATION

Smart instrumentation system - HART communication protocol - Diagnosis of smart instruments - Remote Calibration - Applications: Smart flow and pressure transmitters.

UNIT III **9 Hours**

WIRELESS INSTRUMENTS

Wireless sensors and transducers - Essential components of a Wireless Instrument - Structure of Wireless Instrument - Wireless Bridges, Routers, Gateways and repeaters - Wireless data logging system - Power considerations of Wireless Instruments.

UNIT IV **9 Hours**

WIRELESS SENSOR NETWORK

Architecture of Wireless Sensor Network - Effect of IEEE 1451 standards in Wireless Sensor networks Network Topologies - Energy Issues in Wireless Sensor Networks - Wireless Integrated Network Sensors.

UNIT V **9 Hours**

RECENT TRENDS IN SMART AND WIRELESS TECHNOLOGY

Wireless Human Health Monitoring - Wireless Environmental and Habitat Monitoring Systems - Wireless Consumer Products - WSN based smart precision agriculture system - Challenges and opportunities.

Total: 45 Hours

Reference(s)

1. Smart Sensors, Measurement and Instrumentation, Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
2. Uvais Qidwai, Smart Instrumentation: A data flow approach to Interfacing, Chapman & Hall, 1st Edition, 2013.
3. Kazem Sohraby, Daniel Minoli, Taieb Z Nati, Wireless sensor networks: technology, protocols,and applications, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
4. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Edgar H. Callaway.
5. Halit Eren, Wireless Sensors and Instruments Networks, Design and Applications, Taylor and Francis group, 2006.

22EI046 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

Course Objectives

- To understand the concept of micromachining techniques.
- To get adequate knowledge about various etching techniques in micromachining.
- Analyze the Integration of Polymer and Optical MEMS.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the characteristics, electrical and mechanical concepts and materials used for MEMS design
2. Outline the working principle and Techniques involved in Micro Sensors based on electrostatic, thermal properties
3. Organize the type of sensors and actuators in MEMS and selecting suitable sensors for the various applications
4. Analyze the four etching techniques and two fabrication methods used for micromachining
5. Compare the polymer MEMS and Optical MEMS based on materials used for fabrication, working principles and application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
2	2	3	1	1	-	-	-	-	-	-	-	-	-	-
3	1	2	3	2	1	-	-	-	-	-	-	-	-	-
4	2	1	2	3	1	-	-	-	-	-	-	-	-	-
5	2	1	2	3	3	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INTRODUCTION

MEMS Technology - Definition - Laws of Scaling - Intrinsic Characteristics of MEMS - Multi disciplinary nature of MEMS - Energy Domains - Sensors, Transducers and Actuators - Silicon based MEMS processes - Stress and strain analysis - Applications of MEMS in various industries.

UNIT II **11 Hours**

MICRO SENSORS

Working principle of Microsystems - Micro actuation techniques - Properties and Types of Micro sensors - Capacitor Types - Thermal Sensing and expansion - Magnetic Actuators - Micromagnetic components - Micro accelerometers

UNIT III **10 Hours**

SENSORS AND ACTUATORS

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements - Applications to Inertia, Pressure, Tactile and Flow sensors - Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials, Acoustic, Tactile and Flow sensors Applications

UNIT IV **8 Hours**

FABRICATION AND MICRO MACHINING

Introduction - Photolithography - Ion implantation - Diffusion - Oxidation- CVD - Physical vapor deposition - Etching Techniques: Dry - Wet Etching; Gas Phase Etchants - Surface Micro Machining LIGA - Micro system packaging materials - Packing Techniques - Bonding and Sealing

UNIT V **7 Hours**

POLYMER AND OPTICAL MEMS

Polymers in MEMS - Polyimide - SU-8 - Liquid Crystal Polymer (LCP) - Parylene -Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS

Total: 45 Hours

Reference(s)

1. Nadim Maluf, An introduction to Micro electro mechanical system design, Artech House, 2011.
2. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu. Tata McGraw-Hill Publishing Company Ltd., 2010.
3. Mohamed Gad-el-Hak, The MEMS Handbook, CRC press Baco Raton, 2012.
4. Julian w. Gardner, Vijay k. varadan and Osama O.Awadelkarim, Micro sensors MEMS and smart devices, John Wiley & son LTD, 2010.

22EI047 POWER ELECTRONICS AND DRIVES 3 0 0 3

Course Objectives

- To obtain the switching characteristic of different types of power semi-conductor devices
- To determine the operation, characteristics and performance parameters of AC, DC converters.
- To understand application of Power Electronics drives.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the construction, operation, and characteristics of power semiconductor devices
2. Analyze the functions of single-phase and three-phase controlled rectifiers.
3. Analyze the functions and operating principle of choppers and cycloconverters.
4. Analyze the functions and operating principle of inverters
5. Select the appropriate drives for various control applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	3	-	-	-	-	-	-	-	1	1	-
2	1	2	3	3	-	-	-	-	-	-	-	1	1	-
3	1	2	3	-	-	-	-	-	-	-	-	1	1	-
4	1	2	-	3	-	-	-	-	-	-	-	1	1	-
5	1	2	3	-	-	-	-	-	-	-	-	1	1	-

UNIT I **9 Hours**

POWER SEMI-CONDUCTOR DEVICES

Construction, Operation, Characteristics of Power Diode - DIAC- SCR - TRIAC - Power transistor, MOSFET and IGBT - Ratings of SCR - Series parallel operation of SCR, di/dt & dv/dt protection.

UNIT II **10 Hours**

CONTROLLED RECTIFIERS

Single Phase and Three phase uncontrolled converter - Single Phase and Three phase half and fully controlled converters - Single phase and Three phase dual converter operation - Effect of source inductance.

UNIT III **9 Hours**

CHOPPERS AND CYCLOCONVERTERS

Principle of chopper operations - control strategies - Step up and step down chopper - Buck and boost switched mode regulators - cycloconverters, Single phase cycloconverters.

UNIT IV **9 Hours**

INVERTERS

Single phase and three phase (both 120 deg mode and 180 deg mode) inverters - PWM techniques: Sinusoidal PWM modified sinusoidal PWM and multiple PWM - Current source inverters - Voltage source inverter - UPS, Thyristor control of heating element

UNIT V **8 Hours**

DRIVES

Determination of speed and torque requirements for specific motion profiles, Introduction to DC drives - AC Drives-Frequency control - Stepper motor drives- Position control- Servo drives- applications.

Total: 45 Hours

Reference(s)

1. Dr.P.S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012.
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters Applications and Design, Wiley India, New Delhi, 3rd Edition, 2010.
3. Singh. M.D & Khanchandani, K.B Power Electronics Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2010.
4. Muhammad H. Rashid, Power Electronics Circuits, Devices & Applications, Prentice Hall of India, New Delhi, 2013.

22OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1											1		
2	1	2					2					1		
3	1	2					2					1		
4	1	2					2					1		
5	1	2					2					1		

UNIT I **9 Hours**

INTRODUCTION TO ENERGY SCIENCE

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources

UNIT II **9 Hours**

ENERGY CONSERVATION IN BUILDINGS

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building- classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing

UNIT III **9 Hours**

SUSTAINABLE CONSTRUCTION

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

UNIT IV **9 Hours**

WATER CONSERVATION & SUSTAINABILITY

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

UNIT V **9 Hours**

ENERGY RECOVERY FROM WASTE

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

Total: 45 Hours

Reference(s)

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011.
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			3									
2	1	2	3		3									
3	1	2	2		3									
4	1	2	3		3									
5	1	2	3		3									

UNIT I **9 Hours**
INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona).

UNIT II **9 Hours**
OBJECTS AND CLASSES
Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**
OPERATOR OVERLOADING AND INHERITANCE
Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **9 Hours**
POLYMORPHISM AND FILE STREAMS
Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer-Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **9 Hours**
TEMPLATES AND EXCEPTION HANDLING
Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall, 2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2006.

22OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2		2									
2	2	3	2		2									
3	3	3	3		3									
4	2	2	2		2									
5	2	2	2		2									

UNIT I **9 Hours**
BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2	3											
3	3	3	3											
4	2	2	2											
5	2	2	2											

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**

TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**

MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**

TEACHING-LEARNING PROCESS

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**

APPLICATIONS

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2	1	1								
2	1	2	2	3								
3	1	1	2	3								
4	1	1	3									
5	1	2	3	3								

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	2	2									
2	2	2	2	2	2									
3	2	2	2	2	2									
4	2	2	2	2	2									
5	2	2	2	2	2									

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015.
6. http://www.springer.com/978-1-4939-2112-6
7. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1		1									
2	3	3	1		2						2			
3	1	3	3		2									
4	2	3	1		2									
5	2	3	1		2									

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer-Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications., 2010.
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2006.
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.

22OME03 MAINTENANCE ENGINEERING **3 0 0 3**

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2												
3					2	2	1							
4	1	2	1		2	2	2							
5	2	2	2		1	1	1							

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					2	1		1						
2					1			3						
3	2											3		
4	2	3							2					
5					2					3				

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop, - Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and Training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, -Working on fragile roofs, work permit Systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined space

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

22OBT01 BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more eco-friendly options.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2				3							
2	2	1		3			1							
3	1	2		2		2	3							
4	2	3				2	3							
5	1	2	3	3			1							

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feedstocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterificati on: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high-speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, and purification - wet and dry milling processes, saccharification- chemical and enzymatic. Production of bio methane and biohydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008.
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007.

22OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1													
2		1												
3	2	1	1											
4								2						
5								2						

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:- Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods - types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

22OFD02 FOOD LAWS AND REGULATIONS 3 0 0 3

Course Objectives

- To introduce the concept of food hygiene, importance of safe food and laws governing it
- To learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- To understand food inspection procedures employed in maintaining food quality

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1											
2		1				1	2	1						
3		1												
4	1	2												
5	1	2												

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi.

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES **3 0 0 3**

Course Objectives

- To understand the importance and different methods of post-harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1			1							
2	1	1												
3	1	2												
4	1		1											
5	2	1	1											

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017.
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- To understand the application of scientific principles in the processing technologies specific to the materials
- To understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- To develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2		2								
2	1	2		2		1								
3	2	2		1		2								
4	2	3		2		2								
5	2	2		2		3								

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3				2		2	2		2		
2	3	2	3				1		2	3		2		
3	3	2	3				2		2	3		2		
4	3	2	3				2		2	3		2		
5	3	2	3				2		2	3		2		

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNITI V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition October 20, 2009.
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007.
3. All about Techniques in Illustration, Barron Educational Series, 2001.
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008.
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000.
6. https://www.marthastewart.com/274411/fashion-crafts

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3			1								
2	3	2	3		2	3		2						
3	3	3	3		2	2		2						
4	3	3	3		2	3		2						
5	3	2			2			3						

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design - Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2					1						
2	2	3	2						2					
3	2	3	2		3									
4	2	2	2						2					
5	2	2	2						2					

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations, 2014.
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013.
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013.
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OPH01 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	1							1		
2	3	2	2	1	1							1		
3	3	2	2	1	1							1		
4	3	2	2	1	1							1		
5	3	2	2	1	1							1		

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future -classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics

Total: 45 Hours

Reference(s)

1. W A Goddard and D W Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P Poole, Jr and Frank J Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W Kelsall, Ian W Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006.
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

22OPH04 BIOPHOTONICS 3 0 0 3

Course Objective:

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	1									
2	3	3	2	2	1									
3	3	3	2	2	1									
4	3	3	2	2	1									
5	3	3	2	2	1									

UNIT I **9 Hours**
INTRODUCTION TO BIOPHOTONICS
Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**
PHOTOBIOLOGY
Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**
BIONANO PHOTONICS
Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**
TISSUE ENGINEERING WITH LIGHT
Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**
BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS
An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supra molecules
- To summarize the soft matter properties of structures and components of life

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	1												
3	2	2												
4	2	2												
5	2	2												

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids. Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

Total: 45 Hours

Reference(s)

1. Richard A L Jones, Soft Condensed Matter, Oxford University Press, UK, 2002.
2. Masao Doi, Soft Matter Physics, Oxford University Press, UK, 2013.
3. Ian W Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007.
4. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and Oleg D Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING

3 0 0 3

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2						1							
3	1	3												
4	2	2												
5	3	3					1							

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, Create Space Independent Publishing Platform, 1st Edition, 2016.
2. E. McCafferty, Introduction to Corrosion Science, Springer, 1st Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2nd Edition, 2008.
5. David E.J. Talbot and James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press, 2nd Edition, 2007.

22OCH02 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	1	2												
3	2	2												
4	1	1	2											
5	1	3	2											

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

22OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1												
2	2	3					1							
3	3	1												
4	2	2					1							
5	3	3					1							

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. S.P. Jiang and Q. Li, Introduction to fuel cells, Springer, 2021.
2. M.M. Eboch, The Future of Energy: From solar cells to flying wind farms, Capstone publishers, 2020.
3. N. Eliaz and E. Gileadi, Physical electrochemistry, fundamentals, techniques and applications, Wiley, 2019.
4. J. Garche and K. Brandt, Electrochemical power sources: Fundamentals systems and applications, Elsevier, 2018.
5. A. Iulianelli and A. Basile, Advances in hydrogen production, storage and distribution, Elsevier, 2016.

22OMA01 GRAPH THEORY AND COMBINATORICS 3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2												
2	1	3												
3	2	3												
4	2	3												
5	3	3												

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2		3			
2									2		2			
3									2		2			
4									3		2			
5									2		2			

UNIT I 9 Hours

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II 9 Hours

PLANNING

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority – Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource – Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour – Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication - Barrier in communication Effective communication - Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Programme Outcomes (POs)

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						1	2		2					
2						1	2		2					
3						1	2		2					
4						1	2		2					
5						1	2		2					

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act - Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments - promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance - functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Programme Outcomes (POs)

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						1	2		2					
2						1	2		2					
3						1	2		2					
4						1	2		2					
5						1	2		2					

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases).

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi, 2003.
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill, 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Understand religion-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		1				1					3		
2	2		2				2					2		
3	2		1				1					2		
4	2		3				3					3		
5	2		1				1					2		

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation.
Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy
Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga- Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Army, navy, Air force and Central armed policed forces- Modes of entry into army, police and CAPF-Naval expeditions & campaigns. History, Geography of Border / Coastal areas. EEZ maritime security & ICG. Modes of Entries in armed forces. Security challenges & role of cadets in Border management.

Aims, Objectives and org of NCC- Incentives- Duties of NCC cadets- NCC Camps: types and conduct.

Total: 45 Hours

Reference(s)

1. Lt. Dr S Rajan and Capt. Dr R Latha, NCC Master, Dream Book Publishing, 2024.
2. R. Gupta, NCC National Cadet Corps A, B & C-Certificate Examination Book, 22nd edition, Ramesh Publishing House, 2022.
3. Singh and Neeraj, A Hand Book of NCC, Kanti Prakashan Publishing, 5th edition, 2021.
4. https://nccorissa.org/old/Doc/Ncc-CadetHandbook.pdf

22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES **3 0 0 3**

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3	2	1				1				2		
2		2	2	2				1				2		
3		3	2	2				1				2		
4		2	2	2				1				2		
5		3	2	2				1				2		

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance.

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT V **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety and Health; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition. Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT 3 0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2				1	1	1						
2	2					1	1	1						
3		2				1	1	1						
4	2	2				1	1	1						
5	2					1	1	1						

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett, "Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006.

22OBM03 HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2				1	1							
2	1	2				2	2							
3	1	2				2	2							
4	1	2				1	1							
5	3	2				1	1							

UNIT I **9 Hours**

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II **9 Hours**

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery: Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System Components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**

INSTRUMENTATION SYSTEMS

Optical sensors, Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

UNIT V **9 Hours**

APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3rd Edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4th Edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th Edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

22AGO01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation
- To acquire knowledge about water harvesting techniques and their implementation
- To practice the design aspects of sustainable rainwater harvesting solutions for communities

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the sources, availability and challenges in water resources management
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Evaluate various rainwater harvesting methods for groundwater recharging

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1						3							
2	2	1												
3	1	1	3				2							
4	1	2	3				2							
5	1	1	3				2							

UNIT I **8 Hours**

WATER RESOURCES

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

UNIT II **10 Hours**

WATER CONSERVATION CHALLENGES

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**

SURFACE RUNOFF HARVESTING

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

UNIT IV **9 Hours**

FLOOD WATER HARVESTING

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**

GROUNDWATER HARVESTING

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd Edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990.

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11.Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1											3	1		
2										1	3	1		
3											3	1		
4										1	3	2		
5										2	3	1		

UNIT I **8 Hours**

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OEE02 ELECTRICAL SAFETY 3 0 0 3

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1				2	1							
2	1	1				1	2	2						
3	1	1				2		2	1					
4	1	1				2	1							
5	1	1				2	1	2	1					

UNIT I **9 Hours**

INTRODUCTION

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical Inspectorate-International standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges-over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, -national electrical safety code ANSI.

UNIT III **9 Hours**

ELECTRICAL SAFETY EQUIPMENT

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

ELECTRICAL SAFETY OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

UNIT V **9 Hours**

HAZARDOUS AREAS

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

Total: 45 Hours

Reference(s)

1. Fordham Cooper, W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

22OCB01 INTERNATIONAL BUSINESS MANAGEMENT

3 0 0 3

Course Objectives

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Demonstrate the role and importance of digital marketing in today’s rapidly changing business environment.
2. Discover the techniques to help organizations to utilize social media for digital marketing.
3. Analyze the key elements and campaign effectiveness of E-Mail marketing and mobile marketing.
4. Evaluate the effectiveness of a digital marketing campaign using Google Analytics.
5. Apply advanced practical skills to plan, predict and manage digital marketing campaign

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3						2		2					
2	3						3		2					
3	3						3		2					
4	3						2		2					
5	3						2		2					

UNIT I **9 Hours**

INTRODUCTION

Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory.

UNIT II **9 Hours**

GLOBALIZATION

Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

UNIT III **9 Hours**

INTERNATIONAL BUSINESS STRATEGIES

Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy.

UNIT IV **9 Hours**

FOREIGN EXCHANGE

Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange.

UNIT V **9 Hours**

EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS

Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory.

Total: 45 Hours

Reference(s)

1. John D Daniels, Lee H.Radebaugh, and Sullivan, "International Business", New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, "International Business", New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, "International Business", New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, "International Business", New Delhi: Pearson Education, 2020.
5. K.Aswathappa, "International Business", New Delhi: Tata McGraw Hill, 2020.

22EI0XA ELEMENTS OF INDUSTRIAL AUTOMATION 1 0 0 1

Course Objectives

- To provide an extended overview and fundamental knowledge in the field of Industrial Automation, while building the necessary knowledge level for further specialization in advanced concepts of Industrial Automation.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Evaluate the PLC program in different applications.
2. Design a PCB based industrial automation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	1	2
2	-	-	2	2	1	-	-	-	-	-	-	-	1	2

15 Hours

INDUSTRIAL AUTOMATION

Study of advanced automation technologies: Artificial Intelligence, Machine Learning, Digital twin technology and its applications. Hands on: PLC Interfacing with VFD-Hands on: Precision Speed control of VFD using PLC Analog Cards -Hands on: Synchronization of VFD using HMI- Hands on: Level Sensors Pressure sensor to the PLC, Plant Graphic Control Interfacing Program with Monitoring systems.

Total: 15 Hours

Reference(s)

1. Dunning, Gary A. Introduction to programmable logic controllers. Cengage Learning, 2005.
2. Bolton, William. Programmable logic controllers. Newnes, 2015.
3. Rohner, Peter. Automation with programmable logic controllers. UNSW Press, 1996.

4. Adrien Bécue. Artificial intelligence and Industry 4.0: challenges and opportunities. Artificial Intelligence Review, 2021.

Resource Person Details

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22EI0XB SMART VISUALIZATION OF INDUSTRIAL PARAMETERS 1 0 0 1

Course Objectives

- To explore the smart visualization of industrial parameters.
- To Implementation of augmented reality in instrumentation and developing IoT applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the concepts of augmented reality and digital twin concepts.
2. Implementation of augmented reality/ digital twin concept in instrumentation monitor industrial parameter.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	2	-
2	-	-	2	2	1	-	-	-	-	-	-	-	-	1

15 Hours

INDUSTRIAL PARAMETERS

Introduction to instrumentation, parameters used in industries, sensor identification, and designing, Implementation of Augmented Reality in instrumentation, development, Project development, Introduction to Internet of Things- implementation of Controllers in IoT (general) - Development of logics for simple IoT systems – Introduction to IIoT – Data transmission protocols AR Foundation- Introduction to Unity Software- Setup- Building Application - Visualizing AR planes – Creaing Placement Indicator – Scripting the placement indicator, Communication Technique IoT & Unity Communication Techniques – Implementation of Hardware Handshake Introduction & Implementation of Digital Twin:3 hours Introduction to Digital twin Concept – Industrial Application of digital Twin – Digital twin Development using AR technique Case Studies of Digital Twin: Case study 1- Case Study 2 – Case Study 3.

Total: 15 Hours

Reference(s)

1. Augmented Reality, Sean Morey, John Tinnell Parlor Press LLC, Oct 2016.
2. Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing by Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, Srikanta Pal.

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22EI0XC AUTOMOTIVE EMBEDDED SYSTEM **1 0 0 1**

Course Objectives

- To analyze the conceptual design of embedded systems, analog and digital designs.
- To analyze the system testing and its performance in industrial application.
- To understand the communication and testing concepts associated in embedded system development for automotive application.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Evaluate the performance of analog and digital peripherals for MSP430 MCU.
2. Evaluate the performance of embedded systems design and its development for automotive application using MSP430.
3. Analyze the signals of communication protocols in automotive clusters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	-	1
2	1	2	2	2	-	-	-	-	-	-	-	-	-	2
3	1	-	2	-	2	-	-	-	-	-	-	-	-	1

15 Hours

AUTOMOTIVE EMBEDDED SYSTEM

Architecture of an Embedded System- Embedded Hardware and Software Design - Analog control - Digital controllers - Electronic Control Units (ECU), Products Details and Product Roadmap - Automotive Instrumentation Cluster Basics - Introduction to Safety Standards (MISRA) - Understand the communication protocols used in automotive application – Software Verification and Validation - System Testing - Test Case Development from Requirements.

Total: 15 Hours

Reference(s)

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, W Bolton, 3/e, Pearson Edu. Press, 2021.
2. D. Paret, Multiplexed Networks for Embedded Systems, Wiley, 2020.
3. W. Voss, A Comprehensible Guide to Controller Area Network, Copperhill Technologies Corporation, 2018.

Resource Person Details

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22EI0XD DATA ANALYTICS AND VISUALIZATION 1 0 0 1

Course Objectives

- Understanding of interoperability in healthcare analytics during the data analytics and visualization.
- Tools and techniques used in summarizing data, its collection, analysis, and processing.
- Know-how of the data interpretation and various techniques used in the process.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Analyze the implications of artificial intelligence on extraction of complex data sets.
2. Interpret data analysis results from a visualization example.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	2	-	-	1	-	-	-	-
2	-	1	2	2	-	1	-	1	-	-	-	-	-	-

15 Hours

DATA ANALYTICS

Introduction to Tableau - Different Products by Tableau - Advantages of Tableau- Introduction to Data Visualization- Applications of Tableau- Companies using Tableau- Features of Tableau- Tableau Terminologies- Tableau Navigations- Tableau Design Flow- How to Connect to a File Source- Understanding of Different Data Sources- Data Source Filters- Data Types - Tableau Operators- String Functions in Tableau- Date Functions - Logical Statements - Aggregate Functions- Joins- Data Blending- Field Operator-Filter- Changing Data Type of a Field from Data Pane-Formatting- Worksheet- Line Chart- Bar Chart- Histogram- Scatter Plot- Pie Chart- Bubble chart- Tableau Forecasting- Tableau Dashboard.

Total: 15 Hours

Reference(s)

1. Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc.
2. Kumar, R.L., Indrakumari, R., Balamurugan, B., & Shankar, A. (Eds.). (2021). Exploratory Data Analytics for Healthcare (1st ed.). CRC Press.

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22EI0XE AUTOMOTIVE COMMUNICATION PROTOCOLS 1 0 0 1

Course Objectives

- To learn the architecture of the ARM Cortex M4 microcontroller.
- To create the programming in embedded automotive communication protocols.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the comprehensive knowledge of the STM32F405 microcontroller and its peripherals.
2. Create the programming and interfacing various components and communication protocols for embedded systems development.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	2	-	-	-	2	-	-	1	1	2
2	3	3	2	3	2	-	-	-	2	-	-	1	1	2

20 Hours

COMMUNICATION PROTOCOLS

Introduction to Auto Edge Development board - introduction to STM32F405 – architecture – memory map – phase locked loop – CAN protocol – Frame Formats of CAN –message filtering- Introduction to LIN– LIN network communication - Introduction to UDS, Service ID’s, NRC – Basic working of OBD - Onboard Diagnostics and the necessity of OBD in Automotive Engineering - Onboard Diagnostics Apps.

Total: 20 Hours

Reference(s)

1. STMicroelectronics. User manual STM32 value line discovery, 2010. UM0919.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. STMicroelectronics. Programming manual: Stm32f10xxx/ 20xxx/ 21xxx/l1xxxxcortex-m3programmingmanual, March 2011.PM0056.
4. STMicroelectronics. Low & medium-densityvalueline, advancedARMbased32 bitMCUwith16to128kbflash, 12timers, ADC, DAC&8 comminterfaces, 2011.DocID16455.

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22EI0XF ADVANCED STM32 ARM PROGRAMMING TECHNIQUES 1 0 0 1

Course Objectives

- To learn the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
- To learn STM ARM Internal Peripherals Programming and Communication Protocols.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
2. Outline the STM ARM Internal Peripherals Programming and CAN Communication Protocols.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	2	-	-	-	2	-	-	1	1	2
2	3	3	2	3	2	-	-	-	2	-	-	1	1	2

5 Hours

INTRODUCTION TO STM32 32-BIT MICROCONTROLLER

Introduction to Microcontroller – Von Neumann and Harvard architecture – RISC vs CSIC- Explore the STM32F series, covering its key features, architecture, functional overview, Memory organization-Memory Map, pinout, and pin descriptions. Gain insights into the electrical characteristics of STM32 integrated circuits.

STM32 ARM I/O PROGRAMMING **5 Hours**

Dive into GPIO and I/O programming, along with interfacing techniques for relays, optoisolators, and limit switches.

STM ARM INTERNAL PERIPHERALS PROGRAMMING **5 Hours**

Timers and counters, covering timer and delay generation, compare register, waveform output, timer input capture, and PWM. Explore PWM applications in electric vehicle scenarios- ADC characteristics and programming with STM32 ARM, including interfacing with position sensors- DAC applications and the programming of DAC for various functionalities.

COMMUNICATION PROTOCOLS **5 Hours**

CAN protocol, covering frame formats, understanding CAN nodes, signaling, bus states, bit timing calculation, and networking with transceivers. Explore the bxCAN peripheral of STM32, including self-testing modes and block diagrams- UART, its functionality, and programming aspects- SPI, its working principles, and programming with a focus on interfacing with MEMS accelerometer sensors.

Total: 20 Hours

Reference(s)

1. Embedded Systems: ARM Programming and Optimization by Jason D. Bakos, 2nd Edition, Elsevier, 2023.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. Embedded System Design with ARM Cortex-M Microcontrollers: Applications with C, C++ and MicroPython by Cem Ünsalan , Hüseyin Deniz Gürhan , Mehmet Erkin Yücel, Springer, 2022.

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22EI0XG INTELLIGENT SENSOR DESIGN 1 0 0 1

Course Objectives

- Conceptualize the application and working principle of intelligent sensors for measuring physical and electrical parameters used in industrial automation.
- Installing, troubleshooting, and maintaining industrial automated and electrical production systems using Intelligent Sensor.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the performance of 1D, 2D and QR code identification sensors in the span of low frequency to ultra- high frequency speed.
2. Apply the industrial parameters such as displacement, distance, pressure, level and flow using smart sensors in terms of industrial standards.
3. Analyze the rate of pollution in the industrial environment using Dust Measurement Device.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	2	-	2	-	-	-	-	-	2	3
2	3	3	2	-	2	-	2	-	-	-	-	-	2	3

20 Hours

SENSOR DESIGN

Presence Absence detection- Presence Detection - Belt conveyor with Sensors- Smart Industrial Instrumentation Level, Pressure and Flow Sensors Industry 4.0 – Working demonstration of I4.0 with JSON Commands, Motion control sensors – Encoders - Rotary/Absolute/Programmable - Identification Kit- 1D/2D Barcodes, RFID Tags Identification - Robot Cell Area Guarding Demo Kit using DeTec4 Safety Light Curtains.

Hands-on Training: 2D Vision Kit with Smart Camera- OCR Reading and Quality Inspection - 3D Vision camera -Long Distance Measurement Sensor Kit - Displacement Measurement Kit- LiDAR Scanner for Anti-collision on Mobile car - Safety Functionality Simplified - Demo Kit - Area Guarding with Safety Laser Scanner Kit - Dust Measurement Device for Continuous Emission Measurement

Total: 20 Hours

Reference(s)

1. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, Smart sensors for industrial internet of things, Springer International Publishing, 2021.
2. Sick Sensor Materials

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22EI007 / 22EIH07 / 22EIM07 DATA ANALYTICS FOR IoT **3 0 0 3**

Course Objectives

- To understand the basics of nature of data.
- To understand basic operation in data analysis using python.
- To understand data manipulation using pandas library.
- Data visualization using different types of charts.
- To understand basic python program for IoT application.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the nature of the data processing quantitatively and qualitatively using python.
2. Analyze the various data operations performed using NumPy library.
3. Analyze the data manipulation process using pandas library in python.
4. Apply data visualization techniques to interpret the data with various parameters.
5. Construct IoT projects using python and Raspberry Pi.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	-	-	-	-	-	-	-	-	-	2	-
2	2	3	2	-	3	-	-	-	-	-	-	-	2	2
3	2	3	2	3	3	-	-	-	-	-	-	-	2	2
4	2	2	2	3	3	-	-	-	-	-	-	-	3	-
5	2	1	-	3	2	-	-	-	1	1	-	-	3	-

UNIT I **9 Hours**

INTRODUCTION TO DATA ANALYSIS AND PYTHON

Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative, Data Analysis Python and Data Analysis, Installing Python, and writing Python Code, IPython, The IDEs for Python SciPy.

UNIT II **9 Hours**

BASIC OPERATIONS USING PYTHON

The NumPy Library, The NumPy Installation, Basic Operations Indexing, Slicing, and Iterating Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, General Concepts, Structured Arrays, Reading and Writing Array Data on Files

UNIT III **9 Hours**

DATA ANALYSIS

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files

UNIT IV **9 Hours**

DATA MANUPULATION

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

UNIT V **9 Hours**

DATA VISUALIZATION

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

Total: 45 Hours

Reference(s)

1. Fabio Nelli, Python Data Analytics, APRESS, 2015.
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK, 2020.
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK, 2015.
4. Peters Morgan,Data Analysis from Scratch with Python, AI Sciences, 2016.
5. Agus kurniawan,Micropython for ESP8266 Development workshop, PE PRESS, 2016.
6. Charles Bell, MicroPython for the internet of Things, Apress, 2017.

22EI008 ROBOTICS AND AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with the design, functioning and applications of robots.
- To differentiate the robotic sensors, actuators and end-effectors.
- To formulate the control algorithms and path planning algorithms for the robots.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the evolution of robotics.
2. Analyze the basic concepts associated with the design, functioning and applications of robots.
3. Apply the kinematics of a robotic manipulator.
4. Design the control algorithms and path planning algorithms for the robots.
5. Select the suitable sensor, actuator and gripper for the robot.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	3	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	3

UNIT I **8 Hours**

FUNDAMENTALS OF ROBOTICS

Automation and robots - a brief history of robotics - definition and laws of robotics - anatomy of robot - robot classifications - robot specifications - robot configurations - robot links - robot joints - performance parameter - applications of robots.

UNIT II **11 Hours**

ROBOT KINEMATICS

Robot architecture - pose of a rigid body - coordinate transformation - homogenous coordinates - Denavit and Hartenborg (DH) parameters - forward position analysis - inverse position analysis - velocity analysis: The Jacobian matrix, link velocities, singularity - acceleration analysis. Mobile robots dynamics (Newtonian dynamics).

UNIT III **8 Hours**

ROBOT POWER SOURCES AND END EFFECTOR

Power Sources: Hydraulic, pneumatic and electric drives - mechanical transmission-gear transmission, belt drives, cables, roller chains, rotary to linear motion conversion, rotary to rotary motion conversion. End Effector: Types of end effector - mechanical grippers - vacuum cups - magnetic grippers - adhesive grippers - hooks, scoops, miscellaneous devices - tools as end effector - the robot end effector interface - selection and design of the gripper.

UNIT IV **8 Hours**

ROBOTIC SENSORS AND VISION

Sensors in robotics - classification - tactile, proximity and range sensors - sensors based systems; Introduction to machine vision - the sensing and digitizing function in machine vision - image processing and analysis - training the vision system - robot programming and languages

UNIT V **10 Hours**

PATH PLANNING, CONTROL OF ROBOTIC MANIPULATORS AND APPLICATIONS

Considerations on trajectory planning - joint interrelated trajectories - cartesian path trajectories - control of robot - PID control - computed torque technique - Multiple robots - Machine interface Robots in manufacturing and non-manufacturing application - Robot cell design - selection of a robot.

Total: 45 Hours

Reference(s)

1. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Prentice Hall of India Private Limited, New Delhi, 2010.
2. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, Industrial Robotics, Tata McGraw-Hill Education, 2012.
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2013.
4. K S Fu,Ralph Gonzalez,C S G Lee, Robotics: Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Education, 2010.
5. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering - An integrated approach, Prentice Hall of India, New Delhi, 2012.
6. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, Springer-Verlog Berlin Heidelberg, 2008.

22EI009 BUILDING AUTOMATION 3 0 0 3

Course Objectives

- To understand the principles and application of Building Automation system and building process control.
- To study the dynamic performance of fire alarm system and various access control systems.
- To get knowledge in security systems of different applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Develop HVAC system architecture for building automation with human comfort.
2. Demonstrate and analyze the process model for heating, cooling and ventilation applications.
3. Design and develop different architecture of fire alarm system using field and panel components.
4. Select the appropriate CCTV access control system design for different applications in security system aspects.
5. Apply perimeter intrusion technology for advanced security system design applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	3	-	-	-	-	-	-	-	-	-	1	1
2	2	-	2	-	-	-	-	-	-	-	-	-	2	1
3	1	-	2	-	-	-	-	-	-	-	-	-	1	1
4	2	-	2	-	-	-	-	-	-	-	-	-	2	1
5	3	-	2	-	-	-	-	-	-	-	-	-	2	1

UNIT I **9 Hours**

INTRODUCTION TO BUILDING AUTOMATION SYSTEM

Fundamentals: Introduction to HVAC - Basic Processes (Heating, Cooling) - Air Properties - Psychometric Chart - Heat Transfer mechanisms - Human Comfort: Human comfort zones - Effect of Heat, Humidity - Heat loss

UNIT II **9 Hours**

PROCESSES

Heating Process & Applications: Boiler, Heater - Cooling Process and Applications: Chillers - Ventilation Process and Applications - Central Fan System - AHU - Exhaust Fans - Unitary Systems - VAV, FCU - Energy Saving concept & methods - Lighting control - Building efficiency improvement - Green Building - Leadership in Energy and Environmental Design (LEED) Certification concept and examples

UNIT III **10 Hours**

FIRE ALARM SYSTEM (FAS)

Introduction to fire alarm system - Fire modes, Principles of operation, FAS Components: Field Components, Panel Components and Applications. Power Supply design for FAS. Cause & effect matrix: Examples. Fire Standards: NFPA 72A, BS 5839, Indian Standards

UNIT IV **9 Hours**

SECURITY SYSTEMS

Introduction to Security Systems, Concepts of Access Control System: Access Components, Access control system Design. CCTV: Camera: Operation & types, Camera Selection Criteria, NVR / SAN / Unified storage based design, DVM, Network design, Storage design and CCTV Applications

UNIT V **8 Hours**

PERIMETER INTRUSION SYSTEM

Concept, Components, Technology and Advanced Applications Security Design: Security system design for verticals

Total: 45 Hours

Reference(s)

1. Reinhold A. Carlson, Robert A. Di Giandomenico, Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs), R.S. Means Company, Inc 2012.
2. William B. Riddens, Understanding Automotive Electronics, Sixth Edition, Butterworth Heinemann Woburn, 2010.
3. Michael F. Hordeski, HVAC Control in the New Millennium, First edition, Fairmont Press, 2011.
4. NJATC Building Automation Control Devices and applications, First edition, Amer Technical Pub, 2012.

22EI010 INTELLIGENT AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with Robotic Process Automation.
- To develop practical skills in using RPA tools and platforms to automate repetitive tasks, streamline business processes, and improve operational efficiency.
- To develop skills in implementing intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the basic concepts of Intelligent Automation, applications and implementation procedures.
2. Implement intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.
3. Design and deploy intelligent automation systems.
4. Outline the advanced topics in intelligent automation, such as cognitive automation, robotic process automation (RPA), and adaptive automation.
5. Apply theoretical knowledge and practical skills to develop innovative solutions that maximize operational efficiency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	2
2	3	1	2	1	-	-	-	-	-	-	-	-	-	2
3	3	1	2	2	-	-	-	-	-	-	-	-	-	2
4	3	1	2	3	-	-	-	-	-	-	-	-	-	2
5	3	1	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

INTRODUCTION TO INTELLIGENT AUTOMATION

Introduction to Intelligent Automation(IA) - Differentiating IA from AI - IA technologies - implementation of IA - IA use cases.

UNIT II **9 Hours**

AI TECHNOLOGIES FOR INTELLIGENT AUTOMATION

Introduction to AI technologies used in IA such as natural language processing, computer vision, predictive analytics. AI implementation in robotics.

UNIT III **10 Hours**

INTELLIGENT PROCESS AUTOMATION

Introduction to IPA-Differences between IPA and RPA-Benefits of IPA-Role of Intelligent Process Automation in Automation-Server based robots-Intelligent workflow solutions that aid in management, integration and handoff processes-cognitive agents-optical character recognition-chatbots.

UNIT IV **10 Hours**

COGNITIVE AUTOMATION AND DECISION MAKING

Fundamentals and principles - interdisciplinary nature of cognitive science - representations for information and knowledge - principal technology enablers for cognitive computing - cognitive computing architectures, approaches, applications. Cognitive computing and neural networks - adaptive automation.

UNIT V **8 Hours**

APPLICATIONS

Case studies and real-world examples of successful intelligent automation implementations

Total: 45 Hours

Reference(s)

1. Bornet, Pascal & Barkin, Ian & Wirtz, Jochen, Intelligent Automation - Learn How to Harness Artificial Intelligence to Boost Business & Make Our World More Human, 2020.
2. Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach. Prentice Hall, 2010.
3. Vijay Raghavan, Venkat Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications, 2016.
4. Alok Mani Tripathi, Learning Robotic Process Automation, Packt Publishing, 2018.
5. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Independently Published, 1st Edition, 2018.

22EI011 SMART MANUFACTURING 3 0 0 3

Course Objectives

- To develop a comprehensive understanding of smart manufacturing concepts, technologies, and their impact on the industry.
- To implement and manage smart manufacturing systems, including IoT connectivity, data analytics, and advanced manufacturing technologies.
- To apply theoretical knowledge and practical skills to optimize production processes, enhance quality control, and drive efficiency and productivity in smart manufacturing environments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Demonstrate smart manufacturing principles, technologies, and their application in real-world scenarios.
2. Implement connectivity solutions and leverage the Internet of Things (IoT) to enable seamless communication and collaboration among machines, systems, and stakeholders.
3. Apply data analytics and artificial intelligence techniques to optimize manufacturing processes, improve product quality, and enable predictive maintenance.
4. Evaluate and select appropriate advanced manufacturing technologies, such as additive manufacturing and robotics, to enhance production efficiency and flexibility.
5. Design and execute strategies for the successful implementation and management of smart manufacturing systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	2
2	3	1	2	1	-	-	-	-	-	-	-	-	-	2
3	3	1	2	2	-	-	-	-	-	-	-	-	-	2
4	3	1	2	3	-	-	-	-	-	-	-	-	-	2
5	3	1	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

INTRODUCTION

Smart manufacturing - implementing smart manufacturing across an industry - Industry 4.0 and international perspective - role of hardware and software in smart manufacturing.

UNIT II **10 Hours**

INDUSTRIAL IOT AND CONNECTIVITY IN SMART MANUFACTURING

Industrial Internet of Things and Cyber Manufacturing Systems(CMS) - Cyber Physical systems(CPS) engineering for manufacturing - Model-Based Engineering of Supervisory Controllers for Cyber- Physical Systems .CPS-Based Manufacturing with Semantic Object Memories and Service Orchestration for Industry4.0 Applications - Integration of a Knowledge Database and Machine Vision within a Robot-Based CPS - Interoperability in Smart Automation of Cyber Physical Systems - Communication and Networking for the Industrial Internet of Things.

UNIT III **10 Hours**

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS FOR MANUFACTURING

Application of CPS in machine tools - Manufacturing CPS (IIOT) - CPS intelligence - Big Data and Machine Learning for the Smart Factory - Solutions for Condition Monitoring, Diagnosis and Optimization - Overview of the CPS for Smart Factories Project: Deep Learning, Knowledge Acquisition, Anomaly Detection and Intelligent User Interfaces.

UNIT IV **8 Hours**

ADVANCED MANUFACTURING TECHNOLOGIES IN SMART MANUFACTURING

Introduction and basic principles - Development of Additive Manufacturing Technology - Generalized Additive Manufacturing Process Chain - Rapid prototyping - Direct Digital Manufacturing - Applications for Additive Manufacture.

UNIT V **9 Hours**

SMART MANUFACTURING TECHNOLOGIES FOR INDUSTRY 4.0

Organizational Transformation towards Industry 4.0 Technologies-The Autonomy of Autonomous Robots-Smart Technologies for Industry 4.0 and Its Future. Digital Twin-Based Smart Manufacturing-Concept and Applications.

Total: 45 Hours

Reference(s)

1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Concepts and Methods, Elsevier, 2020.
2. Sabina Jeschke,Christian Brecher,Tobias Meisen,Denis ozdemir,Tim Eschert,Industrial Internet of Things,Springer, 2017.
3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2015.
4. Jayakrishna Kandasamy, Kamalakanta Muduli, V. P. Kommula, Purushottam L. Meena, Smart Manufacturing Technologies for Industry 4.0: Integration, Benefits, and Operational Activities, Taylor and Francis, 2023.

22EI012 AI AND EXPERT SYSTEM FOR AUTOMATION

3 0 0 3

Course Objectives

- To understand the fundamentals of artificial intelligence (AI) and expert systems in the context of automation.
- To implement and train machine learning models for automation tasks.
- To design and develop rule-based expert systems for automation decision-making.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Interpret the history, applications, and ethical considerations of AI in automation.
2. Implement and train machine learning models for automation tasks.
3. Interpret the concepts and techniques of expert systems and knowledge representation in automation.
4. Apply natural language processing (NLP) techniques in automation to enable human-computer interaction and language understanding.
5. Investigate real-world applications of AI and expert systems in various industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	-	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO AI AND EXPERT SYSTEMS

Definition and scope of AI - .History and evolution of AI - AI applications in various industries - Ethical considerations in AI - Problem-solving methods in AI - Search algorithms, including depth-first search, breadth-first search, and A* search - Heuristic search and informed search techniques - Constraint satisfaction problems and algorithms

UNIT II **8 Hours**

EXPERT SYSTEMS AND KNOWLEDGE REPRESENTATION

Components and architecture of expert systems- Knowledge representation and reasoning techniques - Rule-based systems and inference engines - Integration of expert systems with other AI techniques

UNIT III **10 Hours**

MACHINE LEARNING ALGORITHMS FOR AUTOMATION

Introduction to machine learning and its relation to expert systems - Supervised, unsupervised, and reinforcement learning algorithms - Training and evaluation of machine learning models - Integration of machine learning with expert systems

UNIT IV **10 Hours**

NATURAL LANGUAGE PROCESSING FOR AUTOMATION

Introduction to natural language processing (NLP) - NLP techniques for language understanding and generation - NLP applications in expert systems, such as chatbots and language-based decision-making-Sentiment analysis and opinion mining in expert systems.

UNIT V **8 Hours**

APPLICATIONS

Process automation-Decision support system-predictive maintenance-supply chain optimization-quality control and inspection-Case study: Develop a comprehensive medical knowledge base containing information information on various diseases, symptoms, risk factors and treatments.

Total: 45 Hours

Reference(s)

1. Joseph C. Giarratano and Gary D. Riley , Expert Systems: Principles and Programming, 4th Edition, 2022.
2. Stuart Russell and Peter Norvig , Artificial Intelligence: A Modern Approach, Pearson, 2010.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. Daniel Jurafsky and James H. Martin,Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 2nd edition, Pearson, 2013.

22EI013 INTELLIGENT CONTROL 3 0 0 3

Course Objectives

- To understand the intelligent control techniques and their applications in various domains.
- To design and implement fuzzy logic, neural network, and genetic algorithm-based controllers.
- To apply intelligent control methodologies to address real-world control problems, enhancing system stability, robustness, and responsiveness.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Interpret the intelligent control principles and techniques.
2. Design and implement intelligent control systems using fuzzy logic.
3. Design and implement intelligent control systems using neural network.
4. Design and implement intelligent control systems using genetic algorithm.
5. Outline the challenges in practical implementation of intelligent control system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	2	1	-	-	-	-	-	-	-	-	-	2
2	3	-	2	1	-	-	-	-	-	-	-	-	-	2
3	3	-	2	2	-	-	-	-	-	-	-	-	-	2
4	3	-	2	3	-	-	-	-	-	-	-	-	-	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO INTELLIGENT CONTROL

Overview of control systems and their significance in various domains - Introduction to intelligent control and its applications - Comparison of conventional control and intelligent control approaches - Ethical considerations and challenges in implementing intelligent control systems.

UNIT II **10 Hours**

NEURAL NETWORK CONTROL

Introduction to artificial neural networks and their architectures - Neural network-based control approaches, such as adaptive control and model predictive control - Training and learning algorithms for neural network controllers - Case studies and applications of neural network control.

UNIT III **9 Hours**

FUZZY LOGIC CONTROL

Introduction to fuzzy logic and fuzzy sets - Fuzzy logic control architecture and inference mechanisms. Design and tuning of fuzzy logic controllers - Applications of fuzzy logic control.

UNIT IV **9 Hours**

GENETIC ALGORITHM CONTROL

Introduction to genetic algorithms and evolutionary optimization - Genetic algorithm-based control strategies, including PID tuning and optimal control - Encoding, selection, crossover, and mutation operations in genetic algorithms - Applications of genetic algorithm control in complex systems.

UNIT V **8 Hours**

INTELLIGENT CONTROL SYSTEM INTEGRATION AND OPTIMIZATION

Integration of different intelligent control techniques for complex systems - Multi-objective optimization in intelligent control system design - Case studies and practical implementation challenges.

Total: 45 Hours

Reference(s)

1. Jagannathan Sarangapani., Neural Network Control of Nonlinear Discrete-Time Systems, CRC press, 2017.
2. Derong Liu and Panos J. Antsaklis, Intelligent Control Systems: An Introduction with Examples, 2004.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley, 2010.
4. Xinjie Yu, Mitsuo Gen, and Runwei Cheng, Introduction to Evolutionary Algorithms, Springer, 2010.
5. Pedro Ponce-Cruz and Fernando D. Ramirez-Figueroa, Intelligent Control Systems with LabVIEW, Springer, 2010.

22EI014 ANALYTICAL INSTRUMENTS 3 0 0 3

Course Objectives

- To understand the various techniques and methods of analysis that occurs in the various regions of the spectrum.
- To impart an adequate knowledge about chromatography method for analysis of industrial gases.
- To understand the concepts of interaction of electromagnetic radiation with matter.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Select the appropriate spectrophotometer techniques for analysing concentration of chemical solution.
2. Differentiate the chromatographic techniques used for industrial applications.
3. Select specific techniques employed for analyzing gas, dissolved component and monitoring different pollutants in air and water.
4. Compare three different electrodes and analyzers used for the detection of silicon, sodium and dissolved oxygen.
5. Choose the appropriate radiation techniques (NMR, ESR, and EPR) to determine the elements present in the sample.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	2	2	1	-	-	-	1	2	-
2	3	2	-	-	-	2	2	1	-	-	-	1	2	-
3	3	-	-	-	-	2	2	1	-	-	-	1	2	-
4	3	-	-	-	-	2	2	1	-	-	-	1	2	-
5	3	-	-	-	-	2	2	1	-	-	-	1	2	-

UNIT I **9 Hours**

COLORIMETRY AND SPECTROPHOTOMETRY

Beer-Lambert"s law - colorimeters - basic principle of spectroscopy -Emission and absorption of radiation sources and detectors - UV and visible spectrophotometers - single and double beam instruments - IR spectrophotometers - attenuated total reflectance flame photometers - atomic absorption spectrophotometers - FTIR spectrophotometers - flame emission photometers.-mass spectrophotometers.

UNIT II **7 Hours**

CHROMATOGRAPHY

Gas chromatography - Detectors - Liquid chromatography - Applications - High pressure liquid chromatography – Applications.

UNIT III **10 Hours**

GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS

Gas analyzer: oxygen, NOx and H2S types, IR analyzers, thermal conductivity analyzers - air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides and sulphur dioxide estimation - dust and smoke measurements.

UNIT IV **9 Hours**

PH CONDUCTIVITY AND DISSOLVED COMPONENT ANALYZER

Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors - dissolved oxygen analyzer - sodium analyzer - silicon analyzer.

UNIT V **10 Hours**

NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES

Nuclear radiation - microwave spectroscopy - NMR, ESR and EPR spectroscopy - applications - nuclear radiation detectors - GM counter - proportional counter - solid state detectors - X-ray spectroscopy - detectors - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM).

Total: 45 Hours

Reference(s)

1. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 2nd Edition, 2006.
2. G.W. Ewing, Instrumental Methods of Analysis, McGraw Hill, 2004.
3. Liptak, B.G., Process Measurement and Analysis, CRC Press, 2005.
4. Braun, R.D., Introduction to Instrumental Analysis, McGraw Hill, Singapore, 2006.
5. H.W.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, PHI, 2005.

22EI015 VIRTUAL INSTRUMENTATION **3 0 0 3**

Course Objectives

- To provide an overview of Virtual instruments.
- To bring out the overview of the software.
- To know about the programming structure of the software.
- To familiarize the student with the Applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the basics of Virtual or graphical instrumentation concepts.
2. Analyze the overview of G programming, labels, data types and debug the G programming.
3. Select the appropriate structuring concept to be used in graphical programming.
4. Organize the procedure to install DAQ in various OS and its interfacing methods.
5. Implement the IMAQ Motion control and machine vision concepts for industrial application.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	1	1	1	-	-	-	1	-	-	1	1	1
3	1	3	3	2	3	-	-	-	1	-	-	2	2	2
4	1	3	2	3	3	-	-	-	1	-	-	2	2	3
5	1	3	3	3	3	-	-	-	1	-	-	2	2	3

UNIT I **9 Hours**

INTRODUCTION

General functional description of digital instrument - Block diagram of a Virtual Instrument - Advantages of Virtual Instruments over conventional instruments - Architecture of a Virtual Instrument and a its relation to the operating system. Advantages of Virtual Instruments over conventional instruments

UNIT II **9 Hours**

SOFTWARE OVERVIEW

VI-Graphical user interfaces-Controls and indicators-G programming-Labels and Text-Shape,size and color-Owned and free labels-Data type,Format,Precision and representation-Data types-Data flow programming-Editing-Debugging and Running a Virtual Instrument-Graphical programming palettes and tools-Front panel objects-Data types

UNIT III **9 Hours**

PROGRAMMING STRUCTURE

FOR Loops, WHILE Loops, CASE Structure, Formula nodes, Sequence structures - Arrays and Clusters - Array Operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O"s - Attribute modes Local and Global variables. Bundle/Unbundle by name

UNIT IV **9 Hours**

OPERATING SYSTEM AND HARDWARE ASPECTS

Current trends Operating system requirements - Data Acquisition Card(DAQ): DAQ hardware, Grounding methods, Resolution, Analog I/O, Digital I/O - DAQ Software Architecture - Configuring the DAQ hardware/software for temperature measurement.

UNIT V **9 Hours**

APPLICATIONS

IMAQ Motion Control: components of a motion control system, configuration, prototyping and development - Interfacing Servomotor and Stepper motor in LabVIEW. Machine Vision: Edge Detection.

Total: 45 Hours

Reference(s)

1. 1. Garry M Johnson, Labview Graphical Programming, Tata McGraw Hill book Co, New Delhi, 2017.
2. Jovitha Jerome, Virtual Instrumentation Using LabVIEW PHI Learning Pvt. Ltd 1st Edition, 2010.
3. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming made Easy and Fun, Tata McGraw Hill book Co, New Delhi, 2011.
4. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.

22EI016 INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES

3 0 0 3

Course Objectives

- To understand the process involved in petroleum refineries.
- To impact adequate knowledge on the distillation column and its control process.
- To understand the controlling concepts of major unit of refineries like distillation column, reactors, driers, heat exchangers, etc.
- To be acquainted with the safety measures in petroleum industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the production and consumption patterns of fossil fuels in India, evaluating their impact on the energy sector and economy.
2. Compare and evaluate different control techniques used in distillation processes in petroleum industries to enhance efficiency and yield.
3. Analyze the characteristics of physical parameters in chemical reactors and apply suitable control mechanisms for process optimization.
4. Analyze the process parameters of heat exchange systems in petroleum industries and apply advanced control strategies for energy efficiency.
5. Assess the significance of safety instrumentation (zone 0, 1, and 2) and develop strategies to mitigate industrial hazards and accidents.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	1	-	-	-	-	-	-	-	-	-
2	3	3	3	2	-	-	-	-	-	-	-	-	-	-
3	3	3	3	2	-	-	-	-	-	-	-	-	2	-
4	3	2	3	2	1	-	-	-	-	-	-	-	2	-
5	2	3	3	1	1	1	1	-	-	-	-	-	2	-

UNIT I **7 Hours**

INTRODUCTION

Formation of oil and gas - Petroleum exploration, production and refining - refining capacity in India - consumption of petroleum products in India - constituents of crude oil

UNIT II **10 Hours**

DISTILLATION PROCESS CONTROL

Introduction to P & I diagram - atmospheric distillation of crude oil with P&I diagram - Separation of crude oil - vacuum distillation process - thermal conversion process - Catalytic conversion - control of distillation column -feed control - reflux control - reboiler control

UNIT III **9 Hours**

REACTORS PROCESS CONTROL

Control of chemical reactors: temperature control, pressure control - Dryers: control of dryers - batch dryers - atmospheric and vacuum dryers - continuous dryers

UNIT IV **10 Hours**

HEAT EXCHANGE SYSTEM

Control of heat exchangers and evaporators - variables and degrees of freedom - liquid to liquid heat exchangers - steam heaters - condensers - reboiler and vaporizers - cascade control - feed forward control - Feedback control- Integrated approach - evaporators: types of evaporators

UNIT V **9 Hours**

SAFETY INSTRUMENTATION

Hazardous and non-hazardous area - classification of zone 0, zone 1 & zone 2 - pressurization techniques - zener barrier

Total: 45 Hours

Reference(s)

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers Ltd, New Delhi, 2007.
2. B.G. Liptak, Instrumentation in Process Industries, Chilton Book Company, New York, 1973.
3. B.G. Liptak, Instrument Engineers Handbook Volume II, 2003.

22EI017 FIBER OPTICS AND LASER INSTRUMENTATION

3 0 0 3

Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication.
- To be recognized with industrial applications of fibers.
- To understand the fundamental concepts about lasers.
- To identify and describe various fiber optic imaging and optoelectronic sensor applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the properties of optical fibers, their light sources, and detectors to optimize signal transmission and efficiency.
2. Apply fiber-optic sensors for the measurement of various physical quantities in industrial applications.
3. Analyze the fundamental principles of lasers, classify different types, and examine their working mechanisms.
4. Analyze the applications of lasers in industrial processes such as material processing, measurement, and pollutant detection.
5. Apply laser instruments in various medical applications and analyse their effectiveness in surgical and therapeutic procedures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
2	3	2	1	2	-	-	-	-	-	-	-	-	2	-
3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
4	3	2	2	2	-	-	-	-	-	-	-	-	-	2
5	3	2	2	2	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Principles of light propagation through a fiber - different types of fibers and their properties - relative merits and demerits - fiber optics production and components - technology of preformed fabrication - fiber drawing - mechanical and thermal characteristics - light sources - photo detectors -source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III **9 Hours**

LASER FUNDAMENTALS

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials – removal and vaporization - calculation of power requirements of laser for material processing

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non- destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology

Total: 45 Hours

Reference(s)

1. J.M. Senior, Optical Fiber Communication - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. G. Keiser, Optical Fiber Communications, McGraw Hill, 2010.
4. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2009.
5. Donald J. Sterling, Technicians Guide to Fiber Optics, Delmar publisher, 2009.
6. Jelinkova, Helena, editor.Lasers for medical applications: diagnostics, therapy and surgery. Elsevier, 2013.

22EI018 POWER PLANT INSTRUMENTATION AND CONTROL

3 0 0 3

Course Objectives

- To gain knowledge on different methods of power generation.
- To provide clear view of the various measurements involved in power generation plants.
- To understand about the Piping and Instrumentation (P&I) diagram.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply different methods of power generation and analyse the basic building blocks of a thermal power plant.
2. Apply suitable measurement techniques for electrical and non-electrical parameters in a thermal power plant and analyse their significance.
3. Apply control schemes for combustion processes, including air-fuel ratio, draught, pulverizer, flue gas dew point, and soot blowing, and analyse their efficiency.
4. Analyze major boiler control schemes for feedwater, drum level, steam temperature, and boiler interlocks to ensure safe and efficient operation.
5. Apply control strategies for nuclear power plants and analyse safety instrumentation and turbine control methods for reliability and efficiency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	2	1
2	2	2	3	1	-	-	-	-	-	-	-	-	3	1
3	1	3	2	1	-	-	-	-	-	-	-	-	3	1
4	1	3	2	1	-	-	-	-	-	-	-	-	2	2
5	1	1	3	3	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

OVERVIEW OF POWER GENERATION

Survey of methods of power generation - hydro, thermal, nuclear, solar and wind power - importance of instrumentation in power generation - thermal power plant - building blocks - combined cycle system-combined heat and power system - sub critical and supercritical boilers-details of boiler processes-P&I diagram of boiler - cogeneration

UNIT II **9 Hours**

MEASUREMENTS IN POWER PLANTS

Electrical measurements - current, voltage, power, frequency, power factor etc.- non electrical parameters -Measurement of feed water flow, air flow, steam flow and coal flow - drum level measurement - steam pressure and temperature measurement - turbine speed and vibration measurement- flue gas analyzer - fuel composition analyzer- pollution monitoring Instruments - dust monitor

UNIT III **9 Hours**

BOILER CONTROL LOOPS I

Coal handling: Pulverizers and Pulverizers control-Furnace Draught control - Combustion control: Fuel/Air ratio, combustion efficiency-oxygen, CO and CO2 trimming, excess air flue gas dew point control - Burners for liquid and solid fuels - burner management - soot blowing operation

UNIT IV **9 Hours**

BOILER CONTROL LOOPS II

Boiler feed water processing and control - Types of boilers like FBC, CFBC, Fluidized Bed - drum level control - steam temperature and pressure control - Super heater control - deaerator control – furnace safety interlocks and boiler interlocks -. boiler efficiency calculation

UNIT V **9 Hours**

NUCLEAR POWER PLANT INSTRUMENTATION AND TURBINE CONTROL

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics - safety instrumentation, reliability aspects. Turbine-control: Types of steam turbines - governing system - Speed and load control - Vibration and shell temperature control - lubricant oil temperature control - cooling system

Total: 45 Hours

Reference(s)

1. Krishnaswamy.K and Ponnibala.M., Power Plant Instrumentation, PHI Learning Pvt.Ltd., New Delhi, 2011.
2. Swapan Basu and Ajay Kumar, Power Plant Instrumentation and Control, Elsevier, 2015.
3. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
4. Liptak B.G., Instrumentation in Process Industries, Chilton Book Company, 2013.
5. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013.
6. David Lindsley, Power Plant control and Instrumentation, Institution of Electrical Engineers, London, 2000.

22EI019 INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES 3 0 0 3

Course Objectives

- To provide exposure to various techniques and methods that occurs in the various regions of food analysis.
- To get an adequate knowledge about various techniques for analysis of food substances.
- To understand the concepts of electrodes and biosensors that has potential applications in food and beverage industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the role of moisture content in food processing and analyze the measurement techniques for turbidity and humidity.
2. Apply the classification of enzyme sensors, biosensors, and electronic noses in food manufacturing and analyze their working principles.
3. Apply the concepts of automatic controllers and indicators in food industries and analyze their effectiveness in maintaining process control.
4. Implement chromatography and mass spectrometry for food product analysis and analyze their accuracy and reliability.
5. Execute analytical instruments such as Scanning Electron Microscopy and Tandem Electron Microscopy and analyze their applications in food quality assessment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	1	-	1	-	-	-	-	-	1	1
2	1	2	3	3	3	-	1	-	-	-	-	-	2	2
3	1	2	3	3	3	-	2	-	-	-	-	-	2	2
4	1	2	3	3	3	-	3	-	-	-	-	-	3	3
5	1	2	3	3	3	-	2	-	-	-	-	-	3	3

UNIT I **9 Hours**

MOISTURE, TURBIDITY AND HUMIDITY MEASUREMENTS

Role of moisture content in food - wet and dry method - IR technique. Humidity - Definitions - role in food processing - classical types - wet and dry bulb hygrometer - Electronic methods. Turbidity and colour: Definition and role, standards and units, basic turbidity meter, light scattering and absorbtion type

UNIT II **9 Hours**

FOOD ENZYMES AND FLAVOUR

Food enzymes and flavour : Human olfaction - Importance of enzyme sensors - biosensors -sensing arrays - Electronics Nose.

UNIT III **9 Hours**

CONTROLLERS AND INDICATORS

Basic control concept - Temperature controller in dryer - ration control in food pickling -atmospheric controller in food preservation.

UNIT IV **9 Hours**

CHROMATOGRAPHY AND MASS SPECTROMETRY IN FOOD INDUSTRY

Basics of gas and liquid chromatography - GC and HPLC Application in food analysis - MS application in food analysis

UNIT V **9 Hours**

AUTOMATION IN FOOD INDUSTRY

Sorting-Food chilling and freezing-Fruits and vegetable processing-Packing of food products-Robotics in food industry

Total: 45 Hours

Reference(s)

1. 1. Nielsen, S.S, Introduction to the chemical analysis of foods- Jones and Bartlett Publishers, Boston, London, 2004.
2. Mahindru,S.N, -Food additives. Characteristics, detection and estimation-. Tata McGraw Hill Publishing Company Limited, New Delhi, 2000.
3. B.G.Liptak, ed -Instrument Engineers Handbook: Process Measurement and Analysis-, Butterworth & Heinemann, 1995.
4. R G. Moreira, T.P Coultate Automatic Control for Food Processing System, 2001.
5. Gouri S Mittal, Computerized control system in the food industry, Marcel Decker Inc. 1997.

22EI020 SEMICONDUCTOR MANUFACTURING 3 0 0 3

Course Objectives

- To characterize the materials based on band gap
- To study the light semiconductor interactions
- To analyze the band gap and defects concentration in fabrication process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits

Course Outcomes (COs)

1. Outline the band origination in chemical bonding and electrical conductivity
2. Differentiate the materials types based on their band gap values and use this knowledge as per their requirements.
3. Attribute the junctions formed in PN diode and its theory.
4. Contrast the solar cell and its working with advantages.
5. Examine the band gap, reflection and transmission percentage of a grown film over substrate with contents of defects.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	1	1	-	-	-	-	-	-	-	-	1	-
2	1	2	1	2	-	-	-	-	-	-	-	-	1	-
3	1	3	1	2	-	-	-	-	-	-	-	-	1	-
4	2	3	1	3	-	-	-	-	-	-	-	-	1	-
5	2	2	1	3	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

ELECTRONIC MATERIALS

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.

UNIT II **9 Hours**

SEMICONDUCTORS

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

UNIT III **9 Hours**

LIGHT-SEMICONDUCTOR INTERACTION

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi"s golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

UNIT IV **9 Hours**

MEASUREMENTS

Four-point probe and van der Pauw method for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission

UNIT V **9 Hours**

MANUFACTURING AND APPLICATIONS

Semiconductor manufacturing: raw materials, Step-by-step process: Cleaning, Film Deposition, Post-deposition Cleaning, Resist Coating, Exposure, Development, Etching & Implantation of Impurities. Quantum wells, wires, and dots: design, fabrication, and characterization techniques. Hetero-junctions and associated band-diagrams

Total: 45 Hours

Reference(s)

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill, 1995.
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2007.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley, 2008.
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York, 2007.
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India, 1997.
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL.
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Guptaon NPTEL.

22EI021 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To understand the fundamentals of the Automotive systems
- To gain knowledge in digital engine control, automotive networking, and diagnostics
- To analyse standards, impacts, and economy of electric vehicles

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the basics of automobile dynamics and design electronics.
2. Analyze automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
3. Use available automotive sensors and actuators while interfacing with microcontrollers/ microprocessors during automotive system design.
4. Implement the networking of various modules in automotive systems, communication protocols, and diagnostics of the sub-systems
5. Analyze standards, impact and economy of Electric Vehicles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	1	-
2	3	2	2	1	-	-	-	-	-	-	-	-	1	-
3	3	2	2	1	-	-	-	-	-	-	-	-	1	-
4	3	3	2	1	-	-	-	-	-	-	-	-	1	-
5	3	3	2	2	-	-	-	-	-	-	-	-	1	-

UNIT I 9 Hours

AUTOMOTIVE FUNDAMENTALS OVERVIEW

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System-Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery --Operating principle.

UNIT II **9 Hours**

AUTOMOTIVE SENSORS

Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor.

UNIT III **9 Hours**

DIGITAL ENGINE CONTROL SYSTEMS

Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics

UNIT IV **9 Hours**

AUTOMOTIVE NETWORKING AND DIAGNOSTICS

Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces, Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics.

UNIT V **9 Hours**

ELECTRIC VEHICLES

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - Legislation and regulation - Standardization - Energy efficiency - Assessing economy of EVs - Fuel economy - Fuel consumption - Greenhouse gas emissions

Total: 45 Hours

Reference(s)

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, John Wiley and Sons, 2012.

22EI022 GREEN ELECTRONICS 3 0 0 3

Course Objectives

- To understand the sustainable practices and principles in electronics manufacturing.
- To implement green electronic solutions, considering energy efficiency, recyclability, and reduction of hazardous materials.
- To evaluate and optimize electronic systems for sustainability, enabling the design and development of eco-friendly electronics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the principles, regulations, and standards, and their importance in green electronics.
2. Apply sustainable design and manufacturing techniques to develop energy-efficient and environmentally-friendly electronic systems
3. Analyze and evaluate the environmental impact of electronic devices
4. Implement circular economy principles into electronic product design.
5. Attribute the social and economic implications of green electronics.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	-	2	-
2	3	2	2	1	-	-	-	-	-	-	-	-	1	-
3	3	2	2	1	-	-	-	-	-	-	-	-	1	-
4	3	3	2	1	-	-	-	-	-	-	-	-	1	-
5	3	3	2	2	-	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION TO GREEN ELECTRONICS

Overview of green electronics and its significance in sustainability - Environmental impacts of electronic devices and e-waste management - Regulatory frameworks and standards for green electronics - Green design principles and life cycle assessment.

UNIT II **9 Hours**

ENERGY EFFICIENCY IN ELECTRONICS

Energy consumption analysis in electronic devices - Techniques for improving energy efficiency, such as power management and low-power design - Energy-efficient components and architectures for electronic systems - Energy harvesting and renewable energy sources for powering electronics.

UNIT III **9 Hours**

MATERIALS AND MANUFACTURING FOR GREEN ELECTRONICS

Sustainable materials selection for electronic components and packaging - Design for disassembly and recycling in electronics manufacturing - Reduction of hazardous substances in electronic products - Green manufacturing techniques, such as clean production and waste reduction.

UNIT IV **9 Hours**

DESIGN FOR CIRCULAR ECONOMY

Circular economy principles and their application to electronics - Remanufacturing and refurbishment strategies for extending product lifecycles - Reverse logistics and closed-loop supply chains for electronic products - End-of-life management and responsible disposal of electronic waste.

UNIT V **9 Hours**

GREEN ELECTRONICS CASE STUDIES

Case studies of successful green electronics initiatives and implementations - Emerging trends and technologies in green electronics, such as eco-design software and sustainable packaging - Social and economic implications of green electronics

Total: 45 Hours

Reference(s)

1. Mohamad K. Hasan Green Electronics: Design and Manufacturing, 2008.
2. Ali Emadi and Mehrdad Ehsani, Energy-Efficient Electronics: Principles and Practice, 2016.
3. Casey B. Chiu, Sustainable Electronics: Design for Energy Efficiency and Environmental Responsibility, 2016.
4. Martin Charter Design for the Circular Economy: Second Edition, 2017.
5. John R. Okyere. Green Electronics: Green Bottom Line Impact on Sustainable Product Design and Profitability, 1999.

22EI023 DIGITAL VLSI **3 0 0 3**

Course Objectives

- To learn the fundamentals of VLSI design with the IC Manufacturing Process
- To familiarize with VLSI combinational logic circuits design
- To familiarize with VLSI sequential logic circuits design
- To learn the various arithmetic circuits and testing methodologies
- To familiarize with the different FPGA architectures

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze MOS devices and inverter.
2. Design and analyze combinational logic.
3. Design and analyze Sequential logic.
4. Design and analyze data path cells.
5. Design digital logic using FPGA.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	1	-	-	-	-	-	-	-	-	-	-
2	3	2	3	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	-	-	-	-	-	-	-	-	-	-
4	1	3	3	1	-	-	-	-	-	-	-	-	-	-
5	3	3	3	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

MOS TRANSISTOR PRINCIPLES

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits and Device modelling. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore"s constant, Logical Effort. Case study: Study of technology development in MOS.

UNIT II **9 Hours**

COMBINATIONAL LOGIC CIRCUITS

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic. Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NORA logic.

UNIT III **9 Hours**

SEQUENTIAL LOGIC CIRCUITS

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.

UNIT IV **9 Hours**

DESIGNING ARITHMETIC BUILDING BLOCKS

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing-Manufacturing test principles- Design for testability. Case study: Analysis of area, power and delay for 16 bit adder and 8 bit multiplier.

UNIT V **9 Hours**

IMPLEMENTATION STRATEGIES

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)

Total: 45 Hours

Reference(s)

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, Digital Integrated circuits: A Design Perspective, Prentice Hall of India, 2nd Edition, 2003.
2. N.Weste, K.Eshraghian, Principles of CMOS VLSI DESIGN, A system Perspective, 2nd Edition, Addision Wesley, 2004.
3. A.Pucknell, Kamran Eshraghian, BASIC VLSI DESIGN, Prentice Hall of India, 3rd Edition, 2007.
4. M.J. Smith, Application Specific Integrated Circuits, Addisson Wesley, 1997.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, CMOS Circuit Design, Layout and Simulation, Prentice Hall of India, 2005.

22EI024 REAL TIME EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

- To provide in depth knowledge about embedded processor, its hardware and software
- To understand the embedded system design and their operating system
- To apply knowledge of embedded processor architecture in various applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the architecture and the functionality of ARM Microprocessor
2. Demonstrate the architecture and the functionality of computing devices
3. Outline the basic concepts of operating system
4. Implement an interfacing of networks with Microprocessor/ Microcontroller
5. Design a real time application for various domain using embedded system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	2	-	-	-	-	-	-	-	-	-	-	-
4	2	1	2	-	-	-	-	-	-	-	-	-	2	2
5	2	2	-	-	-	-	-	-	-	-	-	-	2	1

UNIT I **9 Hours**

INTRODUCTION TO ARM PROCEESORS

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT II **9 Hours**

COMPUTING PLATFORM AND DESIGN ANALYSIS

CPU buses - Memory devices - I/O devices - Memory Protection Units - Memory Management Units - Component interfacing - Design with microprocessors - Development and Debugging - Program design - Model of programs - Assembly and Linking - Basic compilation techniques - Analysis and optimization of execution time, power, energy, program size - Program validation and testing.

UNIT III **9 Hours**

PROCESS AND OPERATING SYSTEMS

Multiple tasks and multi processes - Processes - Context Switching - Scheduling policies - Multiprocessor - Inter Process Communication mechanisms - Evaluating operating system performance - Power optimization strategies for processes - Firmware and Operating Systems for ARM processor.

UNIT IV **9 Hours**

HARDWARE ACCELERATES

Accelerators - Accelerated system design-Distributed Embedded Architecture - Networks for Embedded Systems - Network based design - Internet enabled systems.

UNIT V **9 Hours**

CASE STUDY

Hardware and software co-design - Data Compressor - Software Modem - Personal Digital Assistants - Set-Top-Box, System-on-Silicon - FOSS Tools for embedded system development.

Total: 45 Hours

Reference(s)

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide Designing and Optimizing System Software, Morgan Kaufmann publishers, 2004.
2. David E-Simon, An Embedded Software Primer, Pearson Education, 2007.
3. K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, Dreamtech Press, 2005.
4. Tim Wilmshurst, An Introduction to the Design of Small Scale Embedded Systems, Pal grave Publisher, 2004.
5. Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.

22EI025 SOLAR PV FUNDAMENTAL AND APPLICATIONS

3 0 0 3

Course Objectives

- To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.
- To understand the construction details and principle of operations of solar photovoltaic system
- To learn the economic and environmental merits of solar energy for variety applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the radiation principles with respective solar energy estimation.
2. Apply the PV technology principles and techniques of various solar cells / materials for lister energy conversion.
3. Apply economic and environmental merits of solar energy for variety applications
4. Analyze the constructional details of solar photovoltaic system and its applications
5. Design the applications of solar energy sources to enhance the passive architecture.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	1	-	1	-	-	-	-	-	-	-
2	2	2	2	1	2	-	2	-	-	-	-	-	-	-
3	2	1	2	2	1	-	2	-	-	-	-	-	-	-
4	1	2	1	1	1	-	2	-	-	-	-	-	-	-
5	2	2	2	1	2	-	1	-	-	-	-	-	-	-

UNIT I **9 Hours**

SOLAR RADIATION AND COLLECTORS

Solar angles-day length, angle of incidence on tilted surface-Sunpath diagrams-shadow determination-extraterrestrial characteristics-measurement and estimation on horizontal and tilted surfaces-flat plate collector thermal analysis-heat capacity effect-testing methods-evacuated tubular collectors-concentrator collectors-classification-design and performance parameters-tracking systems-compound parabolic concentrators-parabolic trough concentrators-concentrators with point focus-Heliostats-performance of the collectors.

UNIT II **9 Hours**

APPLICATIONS OF SOLAR THERMAL TECHNOLOGY

Principle of working, types-design and operation of-solar heating and cooling systems-solar water heaters-thermal storage systems-solar still-solar cooker-domestic, community-solar pond-solar drying.

UNIT III **9 Hours**

SOLAR PV FUNDAMENTALS

Semiconductor-properties-energy levels-basic equations of semiconductor devices physics. Solar cells-p-n junction: homo and hetro junctions-metal semiconductor interface-dark and illumination characteristics-figure of merits of solar cell -efficiency limits-variation of efficiency with band-gap and temperature-efficiency measurements-high efficiency cells-preparation of metallurgical, electronic and solar grade Silicon-production of single crystal Silicon: Czokralski (CZ) and Float Zone(FZ) method-Design of a complete silicon-GaAs-InP solar cell-high efficiency III-V, II-VI multijunction solar cell; a-Si-H based solar cells quantum well solar cell-thermo-photovoltaic.

UNIT IV **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS

Solar cell array system analysis and performance prediction- Shadow analysis: reliability-solar cell array design concepts-PV system design-design process and optimization-detailed array design-storage autonomy-voltage regulation-maximum tracking-use of computers in array design-quick sizing method-array protection and troubleshooting-centralized and decentralized SPV systems-standalone-hybrid and grid connected system-System installation-operation and maintenances-field experience-PV market analysis and economics of SPV systems.

UNIT V **9 Hours**

SOLAR PASSIVE ARCHITECTURE

Thermal comfort-heat transmission in buildings-bioclimatic classification-passive heating concepts: direct heat gain-indirect heat gain-isolated gain and sunspaces-passive cooling concepts: evaporative cooling-radiative cooling-application of wind, water and earth for cooling; shading-paints and cavity walls for cooling-roof radiation traps-earth air-tunnel. energy efficient landscape design-thermal comfort-concept of solar temperature and its significance-calculation of instantaneous heat gain through building envelope.

Total: 45 Hours

Reference(s)

1. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Alan L Fahrenbruch and Richard H Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, 1983.
4. Larry D Partain, Solar Cells and their Applications, John Wiley and Sons, Inc, 1995.
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.

6. Sodha, M.S, Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S. Solar Passive Building, Science and Design, Pergamon Press, 1986.
7. Krieder, J and Rabi, A., Heating and Cooling of Buildings: Design for Efficiency, McGraw- Hill, 1994.

22EI026 PROCESS MODELING AND SIMULATION 3 0 0 3

Course Objectives

- To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.
- To obtain the mathematical model for the real time systems by applying fundamental laws
- To analyze the system performance using simulation of the model with appropriate software

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Formulate and analyze mathematical models for chemical processes by applying basic principles
2. Develop and evaluate mathematical models for chemical processes by applying fundamental conservation laws.
3. Analyze mathematical models for various chemical and physical systems, including reactors, separation units, and transport processes.
4. Implement and evaluate process simulation techniques using sequential modular and equation-oriented approaches
5. Develop and solve mathematical models for chemical processes using process simulators.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3	2	-	-	-	-	-	-	-	1	-	2
2	3	2	3	2	-	-	-	-	-	-	-	1	-	2
3	3	2	3	2	-	-	-	-	-	-	-	1	-	2
4	3	2	3	2	-	-	-	-	-	-	-	1	-	2
5	3	2	3	2	2	-	-	-	-	-	-	1	-	2

UNIT I **9 Hours**

INTRODUCTION

Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Review of numerical techniques, Model simulation.

UNIT II **9 Hours**

FUNDAMENTAL LAWS

Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibrium, bubble and dew points.

UNIT III **9 Hours**

MODELING OF SPECIFIC SYSTEMS

Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.

UNIT IV **9 Hours**

SIMULATION

Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation.

UNIT V **9 Hours**

MATHEMATICAL MODELS

Writing and solving models for simple chemical processes, use of process simulator for solving models for mixer, pump, compressor, heat exchanger, reactor, absorption/distillation column and steady state flow sheet simulation.

Total: 45 Hours

Reference(s)

1. Nagabhushan. S.Sudha.L.K, "Aircraft instrumentation and Systems", International publishing house Private limited, 2014.
2. Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill, 1993.
3. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995.
4. Treager, S., "Gas Turbine Technology", McGraw Hill, 1997.

22EI027 SYSTEM IDENTIFICATION 3 0 0 3

Course Objectives

- To provide an overview system identification based on the Non-parametric methods and spectral analysis methods
- To estimate the system parameters using parametric model structures
- To study the system identification using generalized relay feedback identification
- To familiarize the student with the Identification of systems operating in closed loop as well as practical aspects.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Obtain the mathematical model of a real time system using Non-parametric and spectral analysis methods.
2. Estimate the system parameters using parametric model structures available in the system identification tool box.
3. Determine the mathematical model for stable and unstable system using relay feedback identification methods.
4. Analyze the system Parameter in the closed loop system using direct, indirect and Subspace Identification methods.
5. Explain the procedure and limitation in practical aspects of identification for an experimental setup.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	1	1	-	-	-	-	-	-	-	-	2	-
3	3	3	3	2	-	-	-	-	-	-	-	-	2	-
4	3	3	2	3	-	-	-	-	-	-	-	-	2	-
5	3	3	3	3	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INTRODUCTION

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

UNIT II **9 Hours**

PARAMETER ESTIMATION METHODS

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method- Exercises using system identification toolbox.

UNIT III **9 Hours**

RELAY FEEDBACK IDENTIFICATION

A generalized relay feedback identification method-model; structure selection-relay feedback identification of stable processes: FOPDT and SOPDT model. Relay feedback Identification of unstable processes: FOPDT and SOPDT model- Illustrative examples

UNIT IV **9 Hours**

CLOSED- LOOP IDENTIFICATION

Identification of systems operating in closed loop: Identifiability considerations-direct identification-indirect identification-Subspace Identification methods: classical and innovation forms, free and structures parameterizations

UNIT V **9 Hours**

PRACTICAL ASPECTS OF IDENTIFICATION

Practical aspects: experimental design-input design for identification, notion for persistent excitation, drifts and de-trending-outliers and missing data-pre-filtering-robustness -Model validation and Model structure determination-case studies. Introduction to Nonlinear System Identification

Total: 45 Hours

Reference(s)

1. Arun K. Tangirala "Principles of System Identification Theory and Practice", CRC Press, 2018.
2. Karel J. Keesman, "System Identification an Introduction", Springer, 2011.
3. LennartLjung, "System Identification: Theory for the user", Second edition, Prentice Hall, 1999.
4. Tao Liu, FurongGao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verilog London Ltd, 2012.

22EI028 NON LINEAR CONTROL 3 0 0 3

Course Objectives

- To impart knowledge on phase plane analysis of non-linear systems
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov's theory.
- To introduce the concept of sliding mode control.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the nonlinear systems using phase plane methods.
2. Investigate the nonlinearities of the system using describing function and limit cycle methods.
3. Determine the stability of the given nonlinear system using Lyapunov methods.
4. Apply the linearization concepts in feedback for stabilize the nonlinear MIMO and SISO systems.
5. Design the sliding mode controller for a given nonlinear MIMO system with simulation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	3	3	-	-	-	-	-	-	2	-	1
2	3	3	1	3	3	-	-	-	-	-	-	2	-	1
3	3	3	2	-	-	-	-	-	-	-	-	2	-	2
4	3	3	3	3	3	3	2	-	-	-	-	2	-	3
5	3	3	3	3	3	3	2	-	-	-	-	2	-	3

UNIT I **9 Hours**

PHASE PLANE ANALYSIS

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits- Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems - simulation of phase portraits in MATLAB.

UNIT II **9 Hours**

DESCRIBING FUNCTION

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions- Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. Simulation of limit cycles in MATLAB.

UNIT III **9 Hours**

LYAPUNOV THEORY

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunovs Direct Method-Positive definite Functions and Lyapunov Functions Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunovs Direct Method-Krasovskis Method-Variable Gradient Method-Physically-Control Design based on Lyapunovs Direct Method.

UNIT IV **9 Hours**

FEEDBACK LINEARIZATION

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation- Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum- Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in MATLAB.

UNIT V **9 Hours**

SLIDING MODE CONTROL

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in MATLAB.

Total: 45 Hours

Reference(s)

1. Ramirez, W.; "Computational Methods in Process Simulation", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control", 2nd Edn, McGraw-Hill Book Co., 1990.
3. J A E Slotine and W Li, "Applied Nonlinear control", PHI, 1991.
4. Hasan Khalil, "Nonlinear systems and control", Prentice Hall.
5. S H Zak, "Systems and control", Oxford University Press, 2003.
6. Torkel Glad and Lennart Ljung, "Control Theory-Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
7. G. J. Thaler, “Automatic control systems”, Jaico publishers, 1993.
8. Felix L. Chernousko, Igor M.Ananievski, Sergey A.Reshmin, “Control of Nonlinear Dynamical Systems Methods and Applications, Springer, First Indian Reprint, 2013.

22EI029 ADAPTIVE CONTROL 3 0 0 3

Course Objectives

- To introduce the need for and effects of adaptive control.
- To illustrate study the parameter identification of systems.
- To illustrate the self-tuning of PID controllers based on parameter identification.
- To illustrate the model reference adaptive control.
- To introduce practical application through case studies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the principle of adaptive control schemes to implement in a system with a suitable adaptive control system to eliminate the effect of parameter variation and control.
2. Apply the identified model based on parametric identification methods for controller design/tuning.
3. Design the Deterministic and Stochastic Self Tuning Regulators for a given system.
4. Design of model reference adaptive controller for a given system.
5. Design gain scheduling controller and apply adaptive control schemes for industrial processes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	-	-	-	-	-	-	-	-	2	-	2
2	3	3	2	-	-	-	-	-	-	-	-	2	1	2
3	3	3	3	1	-	1	-	-	-	-	-	2		3
4	3	3	3	1	-	1	-	-	-	-	-	2		3
5	3	3	3	1	-	1	-	-	-	-	-	2		3

UNIT I **9 Hours**

INTRODUCTION

Introduction to adaptive Control-Effects of process Variations-Adaptive Control Schemes-Adaptive Control Problem-Non-Parametric Identification-Step Response Method-Impulse Response Method-Frequency response method.

UNIT II **9 Hours**

PARAMETRIC IDENTIFICATION

Linear in parameter models-ARX-ARMAX-ARIMAX-Least square estimation-Recursive least square estimation-Extended least square estimation-Maximum likelihood estimation-Introduction to non-linear systems identification-Pseudo random binary sequence.

UNIT III **9 Hours**

SELF-TUNING REGULATOR

Deterministic in-direct self-tuning regulators-Deterministic direct self-tuning regulators-Introduction to stochastic self-tuning regulators-Stochastic indirect self-tuning regulator.

UNIT IV **9 Hours**

MODEL REFERENCE ADAPTIVE CONTROLLER

The MIT rule-Lyapunov theory-Design of model reference adaptive controller using MIT rule and Lyapunov theory-Relation between model reference adaptive controller and self-tuning regulator.

UNIT V **9 Hours**

TUNING OF CONTROLLERS AND CASE STUDIES

Design of gain scheduling controller-Auto-tuning of PID regulator-Stability analysis of adaptive controllers-Application of adaptive control in chemical reactor, distillation column and variable area tank system.

Total: 45 Hours

Reference(s)

1. Karl J. Astrom & Bjorn Wittenmark, "Adaptive Control", Pearson Education (Singapore), Second Edition, 2003.
2. Shankar Sastry and Marc Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 1994.
3. I. D. Landau, R. Lozano, and M. M Saad, "Adaptive Control", NY: Springer-Verlag, 1998.
4. Gang Tao, "Adaptive Control Design and Analysis", Wiley-IEEE Press, 2003.
5. Kumpati S. Narendra, Anuradha M. Annaswamy, "Stable Adaptive Control Systems", Prentice Hall, 1989.
6. Chalam, "Adaptive Control Systems: Techniques and Applications", CRC Press, 1987.
7. T. C.H.A. Hsia, ‘System Identification’, Lexington books, 1974.
8. Stephanopoulis G. ‘Chemical Process Control’, Prentice Hall of India, New Delhi, 1990.

22EI030 DIGITAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- To give basic knowledge in digital control system
- To impart necessary knowledge in stability analysis for discrete system
- To model systems in state space representation
- To provide a solution to state equations and to study various computational algorithms
- To know about the compensators in digital controllers

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the sampling theorem for discrete time analysis and reconstruction for an analog signal.
2. Determine the response of a discrete time system and Investigate the stability of the discrete time system
3. Design a digital compensator / controller using frequency and time domain technique.
4. Formulate the state space model and compute the solutions of discrete time state space equation.
5. Design the state feedback controller / observer for a discrete time control system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	2	3	-
2	3	2	1	1	-	-	-	-	-	-	-	2	-	2
3	3	3	3	1	-	1	-	-	-	-	-	2	-	3
4	3	3	3	1	-	-	-	-	-	-	-	2	-	3
5	3	3	3	1	-	1	-	-	-	-	-	2	-	3

UNIT I **8 Hours**

INTRODUCTION TO DIGITAL CONTROL

Introduction - components and configuration of digital control system - discrete time system representation - sampling theorem - Mathematical modelling of sampling process - zero order hold - first order hold - Data reconstruction.

UNIT II **10 Hours**

MODELING AND STABILITY ANALYSIS DISCRETE-TIME SYSTEMS

Revisiting Z transform - Modified Z transform - Mapping of splane to z plane - Pulse transfer function - Pulse transfer function of closed loop system - Jury stability test - Transient and steady state responses.

UNIT III **11 Hours**

DESIGN OF SAMPLED DATA CONTROL SYSTEMS

Root locus method - Bode plot - Lead, lag and lag-lead compensator design using time, frequency domain - Discrete PID Controller - Design of digital control systems with deadbeat response.

UNIT IV **8 Hours**

DISCRETE STATE SPACE MODEL

Introduction to state variable model - Various canonical forms - Characteristic equation, state transition matrix - Solution to discrete state equation - Controllability and observability.

UNIT V **8 Hours**

STATE FEEDBACK DESIGN

Pole placement by state feedback - Set point tracking -controller - Full order observer - Reduced order observer.

Total: 45 Hours

Reference(s)

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2012.
2. K. Ogata, Discrete time control system, Pearson Education Asia, New Delhi, 2011.
3. B.C.Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010.
4. I.J. Nagarath and M. Gopal, Control System Engineering, New age International Pvt. Ltd, New Delhi, 2011.
5. Lawrence J. Kamm, Understanding Electro Mechanical Engineering: An Introduction to Mechatronics, Prentice Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, Mechatronics, Tata McGraw-Hill publishing Company Ltd, 2009.

22EI031 OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN

3 0 0 3

Course Objectives

- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Translate descriptive statements of the design engineering problems in to a mathematical statement of optimization.
2. Apply the concept of calculus of variation and principal of optimality for solving problems
3. Design of Non-linear optimization controller & Design and Tuning a PID controller via optimization technique.
4. Apply the concept of Linear Quadratic method for solving problems
5. Design of optimal low-order feedforward controllers & model based optimization of a Controller

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1	-	-	-	-	-	-	-	2	-	2
2	3	3	3	1	-	-	-	-	-	-	-	2	-	3
3	3	3	3	1	-	1	-	-	-	-	-	2	-	3
4	3	3	3	1	-	-	-	-	-	-	-	2	-	3
5	3	3	3	1	-	1	-	-	-	-	-	2	-	3

UNIT I **8 Hours**

INTRODUCTION TO OPTIMIZATION

Engineering application of Optimization-Statement of an Optimization Problem-Optimal Problem Formulation-Classification of Optimization problem. Optimum design concepts: Definition of Global and Local Optima-Optimality Criteria-Review of basic calculus Concepts-Global optimality.

UNIT II **10 Hours**

CALCULUS OF VARIATION AND HAMILTON FORMULATION

Fundamental concepts – Extremum functionals involving single and several independent functions – Piecewise smooth extremals - Variation of functionals with fixed and free terminal time constrained extrema Pontryagin's minimum principle - State inequality constraints – The Weierstrass Erdmann corner conditions - Solution of Bolza problem. Partial differential equation for cost function – Hamilton Jacobi equation - Principle of optimality, solution of Hamilton Jacobi equation - Matrix Riccati equation - Optimal control law.

UNIT III **10 Hours**

PID DESIGN BY OPTIMIZATION

Unconstrained, Constrained, Lagrange Multipliers, Quadratic Programming, Merit Functions, Line Search, Trust Region Methods, SQP-Introduction, PID Design, Convex-concave Optimization, MIMO PID Tuning via Iterated LMI Restriction, Model and Assumptions, Design Problem, Quadratic Matrix Inequality Form, Linear Matrix Inequality Restriction.

UNIT IV **9 Hours**

LINEAR QUADRATIC CONTROL PROBLEMS

Optimal control by Liapunov method - Parameter optimization – Quadratic performance index -Optimal control of systems - Matrix Riccati equation and solution methods of State regulator and discrete systems - Choice of weighting matrices – Linear Quadratic Guassian control – Kalman filter – H2 and H∞ Control and Optimal estimation

UNIT V **8 Hours**

DESIGN OF OPTIMAL LOW-ORDER FEEDFORWARD CONTROLLERS

Feedforward Structure, Optimal Feedforward Control, Optimal Feedforward Controller Characteristics, Control Signal Considerations, Precompensation, Design Examples. Feedforward controller design using convex optimization and tuning rules for proportional set-point weighting. Plant Models, Controllers and Signals, Error Minimization, Feedforward and Feedback Design, Tuning Rules for Set-Point Weighting.

Total: 45 Hours

Reference(s)

1. Rao S.S.Engineering Optimization, Theory and Practice New Age International Publishers, 4th Edition, 2012.
2. Design of Low-Order Controllers using Optimization Techniques Hast, Martin, 2015.
3. Deb K.Optimization for Engineering Design Algorithms and Examples, PHI, 2000.
4. Arora J.Introduction to Optimization Design-Elsevier Academic Press, New Delhi, 2004.
5. Saravanan R.Manufacturing Optimization through Intelligent Techniques-Taylor & Francis (CRC Press), 2006.
6. Hardley G.Linear Programming-Narosa Book Distributors Private Ltd., 2002.

22EI032 APPLIED SOFT COMPUTING 3 0 0 3

Course Objectives

- To expose the concepts of feedforward and feedback neural networks.
- To provide adequate about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the necessity of soft computing techniques.
2. Analyze the functions and application of Artificial Neural Network
3. Apply the concept of fuzziness involved in various systems
4. Analyze the working of Genetic Algorithm
5. Design the soft computing techniques for linear and nonlinear systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	2	1	-	-	-	-	-	-	-	-	-
2	2	2	1	2	1	-	-	-	-	-	-	-	-	2
3	2	2	1	2	1	-	-	-	-	-	-	-	-	1
4	2	2	1	2	1	-	-	-	-	-	-	-	-	1
5	2	2	1	2	1	-	-	-	-	-	-	-	-	1

UNIT I **9 Hours**

INTRODUCTION TO SOFT COMPUTING

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient –back propagation algorithm- factors affecting back propagation training- applications.

UNIT II **9 Hours**

ARTIFICIAL NEURAL NETWORKS

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory- and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III **9 Hours**

FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets-basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control-Fuzzification-inference and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV **9 Hours**

GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters-Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

UNIT V **9 Hours**

APPLICATIONS

GA application to power system optimization problem- Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural Network interconnection systems- Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox-Stability analysis of fuzzy control systems.

Total: 45 Hours

Reference(s)

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.

22EI033 MACHINE LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To Apply the Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environment that is suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Design machine learning systems and evaluation.
2. Apply probabilistic discriminative and generative algorithms for regression and classification problems and analyze the results
3. Apply an unsupervised algorithm to predict the continuous and categorical data and analyze the results.
4. Apply the machine learning algorithms for to solve real-world problems.
5. Generate machine learning model for regression and classification problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	3	-	-	-	-	-	-	-	-	-	-	-
2	1	2	3	3	2	-	-	-	-	-	-	-	-	-
3	1	2	3	3	2	-	-	-	-	-	-	-	-	1
4	2	2	2	3	3	-	-	-	-	-	-	-	-	1
5	1	1	2	3	3	-	-	-	-	-	-	-	-	-

UNIT I **7 Hours**

INTRODUCTION

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, -hypothesis space and inductive bias, evaluation, cross-validation.

UNIT II **10 Hours**

SUPERVISED LEARNING

Regression-Linear and multilinear regression, polynomial, decision trees, random forest. Classification- k-nearest neighbor algorithm, Classification and Regression Tree, logistic regression, SVM.

UNIT III **10 Hours**

UNSUPERVISED LEARNING

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

UNIT IV **9 Hours**

NEURAL NETWORKS

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

UNIT V **9 Hours**

APPLICATION

Machine Learning Frame works- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

Total: 45 Hours

Reference(s)

1. Stephen Marsland, Machine Learning - An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition, Springer series in Statistics.
4. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine Learning (FOML)", MIT Press, 2012.
5. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms (UML)", Cambridge University Press, 2014.

22EI034 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real-world applications
- To analyze the performance of deep learning architectures for real time applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning
3. Apply deep learning concepts into text and image processing.
4. Design a deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	2	-	-	-	-	-	-	2	-	-
2	1	2	3	1	2	-	-	-	-	-	-	2	-	1
3	1	1	2	3	2	-	-	-	-	-	-	1	-	-
4	1	1	2	3	2	-	-	-	-	-	-	1	-	2
5	1	1	2	3	2	-	-	-	-	-	-	2	-	1

UNIT I **7 Hours**

INTRODUCTION TO MACHINE LEARNING

Learning algorithms, Maximum likelihood estimation, Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

UNIT II **9 Hours**

INTRODUCTION TO DEEP NEURAL NETWORKS

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization.

UNIT III **11 Hours**

DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering.

UNIT IV **11 Hours**

DEEP GENERATIVE MODELS

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

UNIT V **7 Hours**

DEEP REINFORCEMENT LEARNING

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

Total: 45 Hours

Reference(s)

1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner"s Approach", O"Reilly Media, 2017.
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

22EI035 PYTHON PROGRAMMING FOR AI AND ML 3 0 0 3

Course Objectives

- To study uninformed and Heuristic search techniques.
- To introduce Machine Learning and supervised learning algorithms
- To study ensembling and unsupervised learning algorithms

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the appropriate search algorithms for problem-solving
2. Apply reasoning under uncertainty for the models
3. Design of supervised learning models for the application
4. Design of ensembling and unsupervised models for the application
5. Design of deep learning neural network models for the application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	1	2	-	-	-	-	-	-	2	-	-
2	1	2	3	1	2	-	-	-	-	-	-	2	-	-
3	1	1	2	3	2	-	-	-	-	-	-	1	-	-
4	1	1	2	3	2	-	-	-	-	-	-	2	-	-
5	1	1	2	3	2	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

PROBLEM SOLVING

Introduction to AI-AI Applications-Problem solving agents- search algorithms-uninformed search strategies - Heuristic search strategies - Local search and optimization problems - adversarial search - constraint satisfaction problems (CSP)

UNIT II **9 Hours**

PROBABILISTIC REASONING

Acting under uncertainty - Bayesian inference- naive bayes models. Probabilistic reasoning - Bayesian networks - exact inference in BN - approximate inference in BN - causal networks

UNIT III **9 Hours**

SUPERVISED LEARNING

Introduction to machine learning - Linear Regression Models: &Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function - Probabilistic discriminative model - Logistic regression, Probabilistic generative model - Naive Bayes, Maximum margin classifier - Support vector machine, Decision Tree, Random forests

UNIT IV **9 Hours**

ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT V **9 Hours**

NEURAL NETWORKS

Perceptron- Multilayer perceptron, activation functions, network training- gradient descent optimization - stochastic gradient descent, error backpropagation, from shallow networks to deep networks- Unit saturation (aka the vanishing gradient problem) -ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

Total: 45 Hours

Reference(s)

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007.
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008.
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006.
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.
7. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997.
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

22EI036 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To familiarize with the basic concepts and models of the operations research
- To use transportation and assignment model techniques for effective decisions-making.
- To optimization that are tailored to large-scale statistics and machine learning problems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate the basics of convex optimization in linear programming
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Analyze the fundamental concepts of Genetic Algorithm.
4. Analyze the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Design the various optimization techniques involved in PSO for suitable applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	1	2	-	-	-	-	-	-	2	-	-
2	2	2	3	1	2	-	-	-	-	-	-	2	-	-
3	2	1	2	3	2	-	-	-	-	-	-	2	-	-
4	2	1	2	3	2	-	-	-	-	-	-	2	-	-
5	2	1	2	3	2	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

BASICS OF CONVEX OPTIMIZATION

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

UNIT II **9 Hours**

STOCHASTIC AND NONCONVEX OPTIMIZATION

Dual averaging, Polyak- Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

UNIT III **9 Hours**

MODERN OPTIMIZATION IN GA

Genetic algorithm-Introduction-biological background- traditional optimization and search techniques - Genetic basic concepts-operators-Encoding scheme-Fitness evaluation- crossover -mutation-genetic programming-multilevel optimization- real life problem- advances in GA

UNIT IV **9 Hours**

GENETIC PROGRAMMING

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems

UNIT V **9 Hours**

PARTICLE SWARM OPTIMIZATION

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO) - Formulations, Pseudo-code. Applications of PSO and ACO.

Total: 45 Hours

Reference(s)

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International.
2. Stephen Boyd and Lieven Vandenberghe"s book: Convex Optimization.
3. Nesterov"s old book: Introductory Lectures on Convex Optimization: A Basic Course.
4. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers.
5. Genetic algorithms in Search, Optimization, and Machine learning-D.E.Goldberg, Addison- Wesley Publishers.

22EI037 NATURAL LANGUAGE PROCESSING 3 0 0 3

Course Objectives

- Understand the representation and processing of Morphology and Part-of Speech Taggers
- Express different aspects of natural language syntax and the various methods used for processing syntax
- To know about various applications of natural language processing

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the different linguistic components and models of given sentences
2. Design a morphological analyzer for a language using finite state automata concepts
3. Design a parser by providing suitable grammar and words
4. Recognize the semantic role of the sentence and implement the semantic parsing
5. Apply the machine translation and statistical translation to extract the information from the sentence

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	1	1	1	1	-	-	-	-	2	-	-
2	3	1	1	2	2	1	1	-	-	-	-	2	-	-
3	3	1	1	2	1	1	1	-	-	-	-	2	-	-
4	3	1	1	1	2	1	1	-	-	-	-	2	-	-
5	3	1	1	2	2	1	1	-	-	-	-	2	-	-

UNIT I **8 Hours**

INTRODUCTION

Natural Language Processing tasks in syntax, semantics, and pragmatics -Issues - Applications - The role of machine learning - Probability Basics -Information theory - Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models

UNIT II **9 Hours**

MORPHOLOGY AND PART OF SPEECH TAGGING

Linguistic essentials - Lexical synta - Morphology and Finite State Transducers - Part of speech Tagging - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models - Transformation-based Models - Maximum Entropy Models, Conditional Random Fields

UNIT III **10 Hours**

SYNTAX PARSING

Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context-Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs

UNIT IV **10 Hours**

SEMANTIC ANALYSIS

Representing Meaning - Semantic Analysis - Lexical semantics - Word-sense disambiguation - Supervised - Dictionary-based and Unsupervised Approaches - Compositional semantics- Semantic Role Labelling and Semantic Parsing - Discourse Analysis.

UNIT V **8 Hours**

APPLICATIONS

Named entity recognition and relation extraction- Information Extraction (IE) using sequence labelling Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation - Question Answering- VXML Applications

Total: 45 Hours

Reference(s)

1. Daniel Jurafsky and James H. Martin "Speech and Language Processing", Second Edition, Prentice Hall, 2014.
2. Christopher D. Manning and Hinrich Schuetze, "Foundations of Statistical Natural Language Processing", MIT Press, 2014.
3. Roland R. Hausser, "Foundations of Computational Linguistics Human- Computer Communication in Natural Language", Springer, 2014.

22EI038 BIOMEDICAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To understand the role of instrumentation in bio medical engineering field
- To get ample knowledge on Electro-physiological and non-electric parameter measurement
- To understand principles of medical imaging - CT, MRI, diagnostic and therapeutic devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the human physiology and functioning systems of various organs
2. Outline the various electrodes and signal conditioning for electro physiological measurements
3. Examine the techniques for non-electrical parameter measurements like heart rate, respiration rate and blood pressure measurements
4. Outline the techniques used in medical image analysis and biotelemetry
5. Choose the appropriate assistive and therapeutic devices for illness

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	-	-	1	1	1	-	-	-	1	2	-
2	2	2	1	-	-	2	1	1	-	-	-	1	2	1
3	2	2	1	-	-	3	1	2	-	-	-	1	2	1
4	3	2	1	-	-	3	1	2	-	-	-	1	2	1
5	3	2	1	-	-	3	1	2	-	-	-	1	2	1

UNIT I **9 Hours**

HUMAN PHYSIOLOGY AND BIO POTENTIAL ELECTRODES

Cell and their structures - action and resting potential - nervous system: functional organization of the nervous system, structure of nervous system, neurons, synapse -transmitters and neural communication-cardiovascular system- Physiology of heart and lungs - Circulation and respiration.

UNIT II **9 Hours**

ELECTRO-PHYSIOLOGICAL MEASUREMENT

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Electrodes - Micro, needle and surface electrodes - electrical safety - grounding and isolation - Transducer - Selection criteria Einthoven triangle - ECG - EEG - EMG - Lead systems and recording methods - Typical waveforms

UNIT III **9 Hours**

NON - ELECTRICAL PARAMETER MEASUREMENTS

Measurement of blood pressure - Sphygmomanometer - Phonocardiogram - Body Plethysmography - pH of blood - Pulse oximeter - Spirometry

UNIT IV **9 Hours**

MEDICAL IMAGING PARAMETER MEASUREMENTS

X-RAY machine - Computer Tomography - Magnetic Resonance Imaging system - Ultrasonography-Endoscopy - Bio-Telemetry

UNIT V **9 Hours**

DIAGNOSTIC AND THERAPEUTIC DEVICES

Cardiac Pacemakers - Defibrillators - Ventilators- Heart Lung machine - Dialyser- Diathermy - Neurostimulator - Elements of audio and visual aids

Total: 45 Hours

Reference(s)

1. R.S.Khandpur, Hand Book of Bio-Medical instrumentation, Tata McGraw Hill publishing company Ltd., 2016.
2. J.G. Webster, Medical Instrumentation: Application and Design, John Wiley and Sons, New York, 2010.
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Tata McGraw Hill, 2007.
4. E. W. Golding and F. C. Widdis, Electrical measurements and measuring instruments, Ed.5, Pitman Publishing Ltd., London, 1963.
5. Joseph, A., A. Joseph, and Administer. Theory and Problems of Electric Circuits. Mc Graw Hill., 1994.
6. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication

22EI039 DIGITAL IMAGE PROCESSING 3 0 0 3

Course Objectives

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Apply the basics and fundamentals of digital image processing and 2D-transforms.
2. Analyze the techniques of smoothing, sharpening and enhancement in digital images.
3. Analyze the segmentation and features extraction techniques.
4. Execute the restoration concepts and filtering techniques.
5. Implement the image compression using lossy and lossless compression techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1	2	2	-	-	-	-	-	-	-	1	-
2	2	3	1	2	2	-	-	-	-	-	-	-	1	-
3	2	3	1	2	2	-	-	-	-	-	-	-	1	-
4	2	3	1	2	2	-	-	-	-	-	-	-	1	-
5	2	3	1	2	2	-	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Fundamentals of Image processing: Elements of digital image processing systems, Elements of visual perception, Image sensing and acquisition, Image sampling and quantization. Basic relationships between pixels- Two-dimensional mathematical preliminaries

UNIT II **9 Hours**

IMAGE ANALYSIS

Image Transforms: DFT, DCT, Hadamard, Haar, KLT, SVD, Wavelet Transform and Slant transform Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Homomorphic filtering, Frequency domain: Image smoothing and sharpening using frequency domain filters.

UNIT III **9 Hours**

IMAGE SEGMENTATION

Edge detection: Point, line and edge Detection, Detection of isolated points, Line detection, Edge models, Basic edge detection, Edge linking and boundary detection. Thresholding - basic global thresholding, Ots''s method, Multiple, Variable and multivariable thresholding, Region splitting and Region Merging

UNIT IV **9 Hours**

IMAGE RESTORATION AND RECOGNITION

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Constrained Least square filtering, inverse filtering, Wiener Filtering, Wiener filtering, Geometric transformations, Image Recognition: Patterns and pattern classes, Matching-Minimum Distance classifiers

UNIT V **9 Hours**

IMAGE COMPRESSION AND COLOUR IMAGE PROCESSING

Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-length coding, Lossless and Lossy predictive coding, Block transform coding, Wavelet coding, Image Compression Standards. Color image processing fundamentals: Pseudo color image processing- Basics of full color image processing.

Total: 45 Hours

Reference(s)

1. Digital Image Processing, C. Rafeal Gonzalez and E. Richard Woods, Pearson Education, Fourth Edition, 2018.
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2015.
3. Digital Image Processing, S Jayaraman, S Esakkirajan T Veerakumar, Mc Graw-Hill, 2010.
4. Digital Image Processing, K. William Pratt, John Wiley, 2007.
5. Digital Image Processing Using MATLAB, C. Rafeal Gonzalez, McGraw Hill, 2017.
6. Image Processing Theory, Algorithm and Architectures, M.A. Sid Ahmed, McGraw-Hill, 1995.

22EI040 BIO SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To study the characteristics of different bio signals
- To learn linear and non-linear filtering techniques to extract desired information
- To understand various techniques for automated classification and decision making to aid diagnosis

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Preprocess the Biosignals and spectral characteristics
2. Analyze biosignals in time domain & to estimate the spectrum.
3. Apply wavelet detection techniques for biosignal processing.
4. Classify Biosignals using neural networks and statistical classifiers
5. Extract the features using multivariate component analysis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2	1	-	-	-	-	-	-	-	-	-	-
2	3	1	2	1	-	-	-	-	-	-	-	-	-	-
3	3	1	2	1	-	-	-	-	-	-	-	-	-	-
4	3	1	2	1	-	-	-	-	-	-	-	-	-	-
5	3	1	2	1	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

BIOSIGNAL AND SPECTRAL CHARACTERISTICS

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises- Filters- IIR and FIR filters- Spectrum - power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II **9 Hours**

TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

Time series analysis - linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation -Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III **9 Hours**

ADAPTIVE FILTERING AND WAVELET DETECTION

Filtering -LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG - structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV **9 Hours**

BIOSIGNAL CLASSIFICATION AND RECOGNITION

Signal classification and recognition - Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification, Application in Normal versus Ectopic ECG beats.

UNIT V **9 Hours**

TIME FREQUENCY AND MULTIVARIATE ANALYSIS

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis - Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

Total: 45 Hours

Reference(s)

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach", Pearson education Ltd., 2004.
5. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3rd Edition, 2010.

22EI041 HUMAN ASSISTIVE DEVICES 3 0 0 3

Course Objectives

- To study the role and importance of medical assist devices
- To get exposed to functioning of rehabilitation and related aspects.
- To learn concepts of the design aspects of prosthetic and orthotic devices.
- To become familiar with hearing and visual aids.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the various electro mechanical techniques that will help failing heart
2. Analyze the functioning of the hemodialysers for the clearance of urea from the blood.
3. Analyze the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
4. Analyze the various orthodic devices and prosthetic devices to overcome orthopaedic problems.
5. Implement the rehabilitation and electrical stimulation techniques used in clinical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	1	2	-	-	-	-	-	-	1	-
2	2	3	2	2	1	2	-	-	-	-	-	-	1	-
3	2	3	2	2	1	2	-	-	-	-	-	-	1	-
4	2	3	2	2	1	2	-	-	-	-	-	-	1	-
5	2	3	2	2	1	2	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

BASIC COMPONENTS OF BIOMEDICAL SYSTEMS AND CARDIAC ASSIST DEVICES

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

UNIT II **9 Hours**

HEMODIALYSERS

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters

UNIT III **9 Hours**

HEARING AND VISUAL AIDS

Common tests - audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids-principles, drawbacks in the conventional unit, DSP based hearing aids. Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually Challenged, Text to voice converter, Screen readers

UNIT IV **9 Hours**

PROSTHETIC AND ORTHODIC DEVICES

Hand and arm replacement - different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, sensory assist devices.

UNIT V **9 Hours**

REHABILITATION MEDICINE AND STIMULATORS

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device, Transcutaneous electrical nerve stimulator, bio-feedback.

Total: 45 Hours

Reference(s)

1. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006.
2. Levine S.N. (ed), "Advances in Bio-medical engineering and Medical physics", Vol. I, II, IV, inter university publications, New York, 1968.
3. Short Textbook of Prosthetics and Orthotics - R Chinnathurai- Jaypee BrothersMedical Publishers (P) Ltd, 2010.
4. R.S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2nd Edition, 2003.
5. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976.
6. Albert M.Cook and Webster J.G, “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982.

22EI042 MEDICAL IMAGING SYSTEMS 3 0 0 3

Course Objectives

- To study the medical image acquisition and reconstruction techniques
- To get exposed to functioning of radio isotopic imaging equipments.
- To learn concepts of the MRI, image acquisition and reconstruction techniques.
- To become familiar with X-ray and ultra sound imaging systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the nuclear medical imaging techniques for acquisition of images.
2. Analyze the x-ray medical imaging techniques and its imaging quality.
3. Apply the concept of Neuro Magnetic Science in MRI.
4. Analyze the principle and operation modes of Ultrasound Imaging.
5. Implement the radio isotopes and thermography for imaging techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	2	1	1	-	-	-	-	-	-	1	-
2	2	3	2	2	1	1	-	-	-	-	-	-	1	-
3	2	3	2	2	1	1	-	-	-	-	-	-	1	-
4	2	3	2	2	1	1	-	-	-	-	-	-	1	-
5	2	3	2	2	1	1	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

MEDICAL IMAGE FUNDAMENTALS AND ACQUISITION

Introduction to Imaging Techniques - Single crystal scintillation camera - Principles of scintillation camera - multiple crystal scintillation camera - solid state camera - rectilinear scanner. Image Reconstruction - Mathematical Preliminaries for Two and Three Dimensional Image Reconstructions - Radon Transform- Projection Theorem - central slice Theorem- Sinogram.

UNIT II **9 Hours**

X- RAY AND COMPUTED TOMOGRAPHY

Priniciples of sectional imaging- scanner configuration -data acquisition system -image formation principles - conversion of x-ray data in to scan image -2-D image reconstruction Techniques-Iteration and Fourier method- types of CT scanners.

UNIT III **9 Hours**

MAGNETIC RESONANCE IMAGING

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound andcolour flow mapping -applications of diagnostic ultra sound.

UNIT IV **9 Hours**

ULTRASOUND IN MEDICINE

Production of ultrasound - properties and principles of image formation, capture and display - principles of A-mode, B-mode and M-mode display - Doppler ultra sound and colour flow mapping - applications of diagnostic ultra sound.

UNIT V **9 Hours**

RADIO ISOTOPIC AND THERMAL IMAGING

Rectilinear scanners-linear scanners - SPECT - PET Gamma camera radio nuclides for imaging - emission computed CT. Physics of thermography - imaging systems - pyroelectric vidicon camera clinicalthermography - liquid crystal thermography

Total: 45 Hours

Reference(s)

1. Steve Webb, "The physics of medical imaging", Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
2. Jerry L.Prince and Jnathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2006.
3. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics: A John Wiley & sons, Inc., Publication, Fourth Edition, 2002.
4. Z.H. Cho., J-oie, P. Jones and Manbir Singh, Foundations of Medical Imaging: John Wiley and sons Inc. 2003.
5. P.Raghunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine" Concepts and Techniques, Orient Longman, 2007.

22EI043 BRAIN COMPUTER INTERFACE 3 0 0 3

Course Objectives

- To study the basic concepts of brain computer interface
- To get exposed to various signal acquisition methods
- To learn concepts of the signal processing methods used in brain computer interface.
- To become familiar with various machine learning methods of BCI.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the various brain computer interface types and monitoring hardware.
2. Analyze the functioning of the activation patterns and brain stimulations.
3. Execute the various feature extraction methods
4. Analyze the machine learning methods for brain computer interface.
5. Implement the brain computer interface models in various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	2	-	2	-	-	-	-	-	-	1	-
2	2	2	2	2	-	2	-	-	-	-	-	-	1	-
3	2	2	2	2	-	2	-	-	-	-	-	-	1	-
4	2	2	2	2	-	2	-	-	-	-	-	-	1	-
5	2	2	2	2	-	2	-	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION TO BRAIN COMPUTER INTERFACE

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT II **9 Hours**

BRAIN ACTIVATION

Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials -P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III **9 Hours**

FEATURE EXTRACTION METHODS

Data Processing - Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction, Phase synchronization and coherence

UNIT IV **9 Hours**

MACHINE LEARNING METHODS FOR BRAIN COMPUTER INTERFACE

Classification techniques - Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF""s, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT V **9 Hours**

APPLICATIONS OF BRAIN COMPUTER INTERFACE

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

Total: 45 Hours

Reference(s)

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First Edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, 2012.
3. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.
4. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch, " A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, 2007.
5. Ella Hassianien A A, Azar.A.T (Editors), “Brain-Computer Interfaces Current Trends and Applications”, Springer, 2015.

22EI044 HYDRAULICS AND PNEUMATICS **3 0 0 3**

Course Objectives

- To learn hydraulic fluid / Pneumatic air fundamentals including generation and distribution
- To understand working principles, operation of hydraulic and pneumatic components
- To expose to various techniques of circuit building in pneumatics

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Attribute the fundamentals of hydraulic and pneumatic systems.
2. Differentiate the various hydraulic system components, pumps and actuators.
3. Outline the selection criteria for hydraulic system.
4. Choose the appropriate pneumatic system components for the given application.
5. Design of pneumatic circuit for simple applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	1
2	1	3	2	-	-	-	-	-	-	-	-	-	-	2
3	1	1	3	2	-	-	-	-	-	-	-	-	-	3
4	1	1	3	2	-	-	-	-	-	-	-	-	-	3
5	1	1	3	2	-	-	-	-	-	-	-	-	-	3

UNIT I **5 Hours**

FUNDAMENTALS OF HYDRAULICS AND PNEUMATICS
Introduction to fluid power, properties - hydraulic fluids, air. Selection of hydraulic fluids, comparison between hydraulics and pneumatics.

UNIT II **10 Hours**

ELEMENTS OF HYDRAULIC SYSTEMS
Pumps - types, characteristics. Valves for control of direction, flow and pressure - types, typical construction details, Actuators -types and constructional details.

UNIT III **10 Hours**

HYDRAULIC SYSTEM DESIGN

Power pack elements, design. Pipes- material, pipe fittings. seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system.

UNIT IV **10 Hours**

ELEMENTS OF PNEUMATIC SYSTEMS

Components, constructional details, filter, lubricator, regulator, constructional features, types of actuators, control valves for direction, pressure and flow, air motors, air hydraulic equipment.

UNIT V **10 Hours**

PNEUMATIC CONTROL SYSTEM DESIGN

General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method, Karnaugh-Veitchmapping.

Total: 45 Hours

Reference(s)

1. Anthony Esposito,Fluid Power with Application, Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2003.
2. Srinivasan R, Hydraulic and Pneumatic Controls, McGraw Hill education (India) Pvt. Ltd, 2010.
3. MajumdarSR,Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 2003.
4. Majumda SR,Pneumatic Systems: Principles and Maintenance, Tata McGraw- Hill., New Delhi, 1996.
5. Peter Rohner, Fluid Power Logic Circuit Design Analysis, Design, Method and WorkedExamples, The Macmillan Press Ltd., UK 1979.
6. Werner Deppert and Kurt Stoll, Pneumatic Controls: An Introduction to Principles, Vogel-Druck Wurzburg, Germany, 1975.

22EI045 SMART AND WIRELESS INSTRUMENTATION 3 0 0 3

Course Objectives

- To acquire knowledge on smart instrumentation system with their communication protocol
- To know about wireless sensor networks used in various process industries
- To get adequate knowledge on design, development and challenges in smart and wireless technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Outline the functioning elements of a smart sensor and its standards for sensor interfacing
2. Analyze the concepts of smart instrumentation with its HART communication protocol
3. Choose the appropriate wireless instruments for the given applications
4. Attribute industrial wireless technology for process monitoring applications
5. Predict the challenges and opportunities of recent techniques in smart and wireless systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	-	-	-	-	1	-	-	-	-	1	-
2	2	2	2	-	-	-	-	1	-	-	-	-	2	-
3	3	3	3	-	-	-	-	1	-	-	-	-	2	-
4	1	2	2	-	-	-	-	1	-	-	-	-	1	-
5	2	3	1	-	-	-	-	1	-	-	-	-	2	-

UNIT I **9 Hours**

SMART SENSORS

Functional elements of smart sensors: Primary and Secondary sensors - Amplifiers - Filters - Converters - Compensators - Information coding / processing - Data communication - Standards for smart sensor interface Applications.

UNIT II **9 Hours**

SMART INSTRUMENTATION

Smart instrumentation system - HART communication protocol - Diagnosis of smart instruments - Remote Calibration - Applications: Smart flow and pressure transmitters.

UNIT III **9 Hours**

WIRELESS INSTRUMENTS

Wireless sensors and transducers - Essential components of a Wireless Instrument - Structure of Wireless Instrument - Wireless Bridges, Routers, Gateways and repeaters - Wireless data logging system - Power considerations of Wireless Instruments.

UNIT IV **9 Hours**

WIRELESS SENSOR NETWORK

Architecture of Wireless Sensor Network - Effect of IEEE 1451 standards in Wireless Sensor networks Network Topologies - Energy Issues in Wireless Sensor Networks - Wireless Integrated Network Sensors.

UNIT V **9 Hours**

RECENT TRENDS IN SMART AND WIRELESS TECHNOLOGY

Wireless Human Health Monitoring - Wireless Environmental and Habitat Monitoring Systems - Wireless Consumer Products - WSN based smart precision agriculture system - Challenges and opportunities.

Total: 45 Hours

Reference(s)

1. Smart Sensors, Measurement and Instrumentation, Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
2. Uvais Qidwai, Smart Instrumentation: A data flow approach to Interfacing, Chapman & Hall, 1st Edition, 2013.
3. Kazem Sohraby, Daniel Minoli, Taieb Z Nati, Wireless sensor networks: technology, protocols,and applications, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
4. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Edgar H. Callaway.
5. Halit Eren, Wireless Sensors and Instruments Networks, Design and Applications, Taylor and Francis group, 2006.

22EI046 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

Course Objectives

- To understand the concept of micromachining techniques.
- To get adequate knowledge about various etching techniques in micromachining.
- Analyze the Integration of Polymer and Optical MEMS.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the characteristics, electrical and mechanical concepts and materials used for MEMS design
2. Outline the working principle and Techniques involved in Micro Sensors based on electrostatic, thermal properties
3. Organize the type of sensors and actuators in MEMS and selecting suitable sensors for the various applications
4. Analyze the four etching techniques and two fabrication methods used for micromachining
5. Compare the polymer MEMS and Optical MEMS based on materials used for fabrication, working principles and application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
2	2	3	1	1	-	-	-	-	-	-	-	-	-	-
3	1	2	3	2	1	-	-	-	-	-	-	-	-	-
4	2	1	2	3	1	-	-	-	-	-	-	-	-	-
5	2	1	2	3	3	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INTRODUCTION

MEMS Technology - Definition - Laws of Scaling - Intrinsic Characteristics of MEMS - Multi disciplinary nature of MEMS - Energy Domains - Sensors, Transducers and Actuators - Silicon based MEMS processes - Stress and strain analysis - Applications of MEMS in various industries.

UNIT II **11 Hours**

MICRO SENSORS

Working principle of Microsystems - Micro actuation techniques - Properties and Types of Micro sensors - Capacitor Types - Thermal Sensing and expansion - Magnetic Actuators - Micromagnetic components - Micro accelerometers

UNIT III **10 Hours**

SENSORS AND ACTUATORS

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements - Applications to Inertia, Pressure, Tactile and Flow sensors - Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials, Acoustic, Tactile and Flow sensors Applications

UNIT IV **8 Hours**

FABRICATION AND MICRO MACHINING

Introduction - Photolithography - Ion implantation - Diffusion - Oxidation- CVD - Physical vapor deposition - Etching Techniques: Dry - Wet Etching; Gas Phase Etchants - Surface Micro Machining LIGA - Micro system packaging materials - Packing Techniques - Bonding and Sealing

UNIT V **7 Hours**

POLYMER AND OPTICAL MEMS

Polymers in MEMS - Polyimide - SU-8 - Liquid Crystal Polymer (LCP) - Parylene -Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS

Total: 45 Hours

Reference(s)

1. Nadim Maluf, An introduction to Micro electro mechanical system design, Artech House, 2011.
2. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu. Tata McGraw-Hill Publishing Company Ltd., 2010.
3. Mohamed Gad-el-Hak, The MEMS Handbook, CRC press Baco Raton, 2012.
4. Julian w. Gardner, Vijay k. varadan and Osama O.Awadelkarim, Micro sensors MEMS and smart devices, John Wiley & son LTD, 2010.

22EI047 POWER ELECTRONICS AND DRIVES 3 0 0 3

Course Objectives

- To obtain the switching characteristic of different types of power semi-conductor devices
- To determine the operation, characteristics and performance parameters of AC, DC converters.
- To understand application of Power Electronics drives.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Analyze the construction, operation, and characteristics of power semiconductor devices
2. Analyze the functions of single-phase and three-phase controlled rectifiers.
3. Analyze the functions and operating principle of choppers and cycloconverters.
4. Analyze the functions and operating principle of inverters
5. Select the appropriate drives for various control applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	3	-	-	-	-	-	-	-	1	1	-
2	1	2	3	3	-	-	-	-	-	-	-	1	1	-
3	1	2	3	-	-	-	-	-	-	-	-	1	1	-
4	1	2	-	3	-	-	-	-	-	-	-	1	1	-
5	1	2	3	-	-	-	-	-	-	-	-	1	1	-

UNIT I **9 Hours**

POWER SEMI-CONDUCTOR DEVICES

Construction, Operation, Characteristics of Power Diode - DIAC- SCR - TRIAC - Power transistor, MOSFET and IGBT - Ratings of SCR - Series parallel operation of SCR, di/dt & dv/dt protection.

UNIT II **10 Hours**

CONTROLLED RECTIFIERS

Single Phase and Three phase uncontrolled converter - Single Phase and Three phase half and fully controlled converters - Single phase and Three phase dual converter operation - Effect of source inductance.

UNIT III **9 Hours**

CHOPPERS AND CYCLOCONVERTERS

Principle of chopper operations - control strategies - Step up and step down chopper - Buck and boost switched mode regulators - cycloconverters, Single phase cycloconverters.

UNIT IV **9 Hours**

INVERTERS

Single phase and three phase (both 120 deg mode and 180 deg mode) inverters - PWM techniques: Sinusoidal PWM modified sinusoidal PWM and multiple PWM - Current source inverters - Voltage source inverter - UPS, Thyristor control of heating element

UNIT V **8 Hours**

DRIVES

Determination of speed and torque requirements for specific motion profiles, Introduction to DC drives - AC Drives-Frequency control - Stepper motor drives- Position control- Servo drives- applications.

Total: 45 Hours

Reference(s)

1. Dr.P.S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012.
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters Applications and Design, Wiley India, New Delhi, 3rd Edition, 2010.
3. Singh. M.D & Khanchandani, K.B Power Electronics Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2010.
4. Muhammad H. Rashid, Power Electronics Circuits, Devices & Applications, Prentice Hall of India, New Delhi, 2013.

22OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1											1		
2	1	2					2					1		
3	1	2					2					1		
4	1	2					2					1		
5	1	2					2					1		

UNIT I **9 Hours**

INTRODUCTION TO ENERGY SCIENCE

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources

UNIT II **9 Hours**

ENERGY CONSERVATION IN BUILDINGS

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building-classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing

UNIT III **9 Hours**

SUSTAINABLE CONSTRUCTION

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

UNIT IV **9 Hours**

WATER CONSERVATION & SUSTAINABILITY

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

UNIT V **9 Hours**

ENERGY RECOVERY FROM WASTE

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

Total: 45 Hours

Reference(s)

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011.
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			3									
2	1	2	3		3									
3	1	2	2		3									
4	1	2	3		3									
5	1	2	3		3									

UNIT I **9 Hours**

INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona).

UNIT II **9 Hours**
OBJECTS AND CLASSES
Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**
OPERATOR OVERLOADING AND INHERITANCE
Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **9 Hours**
POLYMORPHISM AND FILE STREAMS
Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer-Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **9 Hours**
TEMPLATES AND EXCEPTION HANDLING
Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall, 2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2006.

22OCS02 JAVA FUNDAMENTALS **3 0 0 3**

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2		2									
2	2	3	2		2									
3	3	3	3		3									
4	2	2	2		2									
5	2	2	2		2									

UNIT I **9 Hours**
BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2	3											
3	3	3	3											
4	2	2	2											
5	2	2	2											

UNIT I **9 Hours**
INTRODUCTION
Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**
TECHNOLOGIES
Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**

MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**

TEACHING-LEARNING PROCESS

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**

APPLICATIONS

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2	1	1								
2	1	2	2	3								
3	1	1	2	3								
4	1	1	3									
5	1	2	3	3								

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OME01 DIGITAL MANUFACTURING **3 0 0 3**

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	2	2									
2	2	2	2	2	2									
3	2	2	2	2	2									
4	2	2	2	2	2									
5	2	2	2	2	2									

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015.
6. http://www.springer.com/978-1-4939-2112-6
7. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1		1									
2	3	3	1		2						2			
3	1	3	3		2									
4	2	3	1		2									
5	2	3	1		2									

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer-Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications., 2010.
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2006.
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.

22OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2												
3					2	2	1							
4	1	2	1		2	2	2							
5	2	2	2		1	1	1							

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					2	1		1						
2					1			3						
3	2											3		
4	2	3							2					
5					2					3				

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop, - Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and Training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, -Working on fragile roofs, work permit Systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined space

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

22OBT01 BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more eco-friendly options.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2				3							
2	2	1		3			1							
3	1	2		2		2	3							
4	2	3				2	3							
5	1	2	3	3			1							

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feedstocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterificati on: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high-speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, and purification - wet and dry milling processes, saccharification- chemical and enzymatic. Production of bio methane and biohydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008.
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007.

22OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1													
2		1												
3	2	1	1											
4								2						
5								2						

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:- Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods - types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

22OFD02 FOOD LAWS AND REGULATIONS 3 0 0 3

Course Objectives

- To introduce the concept of food hygiene, importance of safe food and laws governing it
- To learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- To understand food inspection procedures employed in maintaining food quality

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1											
2		1				1	2	1						
3		1												
4	1	2												
5	1	2												

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi.

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES

3 0 0 3

Course Objectives

- To understand the importance and different methods of post-harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1			1							
2	1	1												
3	1	2												
4	1		1											
5	2	1	1											

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017.
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- To understand the application of scientific principles in the processing technologies specific to the materials
- To understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- To develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2		2								
2	1	2		2		1								
3	2	2		1		2								
4	2	3		2		2								
5	2	2		2		3								

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP **3 0 0 3**

Course Objectives

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3				2		2	2		2		
2	3	2	3				1		2	3		2		
3	3	2	3				2		2	3		2		
4	3	2	3				2		2	3		2		
5	3	2	3				2		2	3		2		

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNITI V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition October 20, 2009.
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007.
3. All about Techniques in Illustration, Barron Educational Series, 2001.
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008.
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000.
6. https://www.marthastewart.com/274411/fashion-crafts

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3			1								
2	3	2	3		2	3		2						
3	3	3	3		2	2		2						
4	3	3	3		2	3		2						
5	3	2			2			3						

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design - Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2					1						
2	2	3	2						2					
3	2	3	2		3									
4	2	2	2						2					
5	2	2	2						2					

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations, 2014.
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013.
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013.
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OPH01 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	1							1		
2	3	2	2	1	1							1		
3	3	2	2	1	1							1		
4	3	2	2	1	1							1		
5	3	2	2	1	1							1		

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future -classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics

Total: 45 Hours

Reference(s)

1. W A Goddard and D W Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P Poole, Jr and Frank J Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W Kelsall, Ian W Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006.
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

22OPH04 BIOPHOTONICS 3 0 0 3

Course Objective:

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	1									
2	3	3	2	2	1									
3	3	3	2	2	1									
4	3	3	2	2	1									
5	3	3	2	2	1									

UNIT I **9 Hours**
INTRODUCTION TO BIOPHOTONICS
Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**
PHOTOBIOLOGY
Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**
BIONANO PHOTONICS
Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**
TISSUE ENGINEERING WITH LIGHT
Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**
BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS
An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supra molecules
- To summarize the soft matter properties of structures and components of life

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	1												
3	2	2												
4	2	2												
5	2	2												

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids. Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

Total: 45 Hours

Reference(s)

1. Richard A L Jones, Soft Condensed Matter, Oxford University Press, UK, 2002.
2. Masao Doi, Soft Matter Physics, Oxford University Press, UK, 2013.
3. Ian W Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007.
4. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and Oleg D Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING **3 0 0 3**

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2						1							
3	1	3												
4	2	2												
5	3	3					1							

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, Create Space Independent Publishing Platform, 1st Edition, 2016.
2. E. McCafferty, Introduction to Corrosion Science, Springer, 1st Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2nd Edition, 2008.
5. David E.J. Talbot and James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press, 2nd Edition, 2007.

22OCH02 POLYMER SCIENCE **3 0 0 3**

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	1	2												
3	2	2												
4	1	1	2											
5	1	3	2											

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

22OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1												
2	2	3					1							
3	3	1												
4	2	2					1							
5	3	3					1							

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. S.P. Jiang and Q. Li, Introduction to fuel cells, Springer, 2021.
2. M.M. Eboch, The Future of Energy: From solar cells to flying wind farms, Capstone publishers, 2020.
3. N. Eliaz and E. Gileadi, Physical electrochemistry, fundamentals, techniques and applications, Wiley, 2019.
4. J. Garche and K. Brandt, Electrochemical power sources: Fundamentals systems and applications, Elsevier, 2018.
5. A. Iulianelli and A. Basile, Advances in hydrogen production, storage and distribution, Elsevier, 2016.

22OMA01 GRAPH THEORY AND COMBINATORICS 3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2												
2	1	3												
3	2	3												
4	2	3												
5	3	3												

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2		3			
2									2		2			
3									2		2			
4									3		2			
5									2		2			

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority – Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource – Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour – Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication - Barrier in communication Effective communication - Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Programme Outcomes (POs)

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						1	2		2					
2						1	2		2					
3						1	2		2					
4						1	2		2					
5						1	2		2					

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act - Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments - promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance - functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Programme Outcomes (POs)

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						1	2		2					
2						1	2		2					
3						1	2		2					
4						1	2		2					
5						1	2		2					

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases).

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi, 2003.
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill, 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Understand religion-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		1				1					3		
2	2		2				2					2		
3	2		1				1					2		
4	2		3				3					3		
5	2		1				1					2		

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation.
Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy
Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Army, navy, Air force and Central armed policed forces- Modes of entry into army, police and CAPF-Naval expeditions & campaigns. History, Geography of Border / Coastal areas. EEZ maritime security & ICG. Modes of Entries in armed forces. Security challenges & role of cadets in Border management.

Aims, Objectives and org of NCC- Incentives- Duties of NCC cadets- NCC Camps: types and conduct.

Total: 45 Hours

Reference(s)

1. Lt. Dr S Rajan and Capt. Dr R Latha, NCC Master, Dream Book Publishing, 2024.
2. R. Gupta, NCC National Cadet Corps A, B & C-Certificate Examination Book, 22nd edition, Ramesh Publishing House, 2022.
3. Singh and Neeraj, A Hand Book of NCC, Kanti Prakashan Publishing, 5th edition, 2021.
4. https://nccorissa.org/old/Doc/Ncc-CadetHandbook.pdf

22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES 3 0 0 3

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3	2	1				1				2		
2		2	2	2				1				2		
3		3	2	2				1				2		
4		2	2	2				1				2		
5		3	2	2				1				2		

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance.

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT V **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety and Health; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition. Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT **3 0 0 3**

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2				1	1	1						
2	2					1	1	1						
3		2				1	1	1						
4	2	2				1	1	1						
5	2					1	1	1						

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett, "Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006.

22OBM03 HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2				1	1							
2	1	2				2	2							
3	1	2				2	2							
4	1	2				1	1							
5	3	2				1	1							

UNIT I **9 Hours**

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II **9 Hours**

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery: Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System Components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**

INSTRUMENTATION SYSTEMS

Optical sensors, Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

UNIT V **9 Hours**

APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3rd Edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4th Edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th Edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989.
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

22AGO01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation
- To acquire knowledge about water harvesting techniques and their implementation
- To practice the design aspects of sustainable rainwater harvesting solutions for communities

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the sources, availability and challenges in water resources management
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Evaluate various rainwater harvesting methods for groundwater recharging

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1						3							
2	2	1												
3	1	1	3				2							
4	1	2	3				2							
5	1	1	3				2							

UNIT I 8 Hours

WATER RESOURCES

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

UNIT II **10 Hours**

WATER CONSERVATION CHALLENGES

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**

SURFACE RUNOFF HARVESTING

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

UNIT IV **9 Hours**

FLOOD WATER HARVESTING

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**

GROUNDWATER HARVESTING

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd Edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990.

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1											3	1		
2										1	3	1		
3											3	1		
4										1	3	2		
5										2	3	1		

UNIT I **8 Hours**

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OEE02 ELECTRICAL SAFETY **3 0 0 3**

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1				2	1							
2	1	1				1	2	2						
3	1	1				2		2	1					
4	1	1				2	1							
5	1	1				2	1	2	1					

UNIT I **9 Hours**

INTRODUCTION

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical Inspectorate-International standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges-over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, -national electrical safety code ANSI.

UNIT III **9 Hours**

ELECTRICAL SAFETY EQUIPMENT

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

ELECTRICAL SAFETY OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

UNIT V **9 Hours**

HAZARDOUS AREAS

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

Total: 45 Hours

Reference(s)

1. Fordham Cooper, W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

22OCB01 INTERNATIONAL BUSINESS MANAGEMENT

3 0 0 3

Course Objectives

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Demonstrate the role and importance of digital marketing in today's rapidly changing business environment.
2. Discover the techniques to help organizations to utilize social media for digital marketing.
3. Analyze the key elements and campaign effectiveness of E-Mail marketing and mobile marketing.
4. Evaluate the effectiveness of a digital marketing campaign using Google Analytics.
5. Apply advanced practical skills to plan, predict and manage digital marketing campaign

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3						2		2					
2	3						3		2					
3	3						3		2					
4	3						2		2					
5	3						2		2					

UNIT I **9 Hours**

INTRODUCTION

Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory.

UNIT II **9 Hours**

GLOBALIZATION

Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

UNIT III **9 Hours**

INTERNATIONAL BUSINESS STRATEGIES

Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy.

UNIT IV **9 Hours**

FOREIGN EXCHANGE

Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange.

UNIT V **9 Hours**

EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS

Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory.

Total: 45 Hours

Reference(s)

1. John D Daniels, Lee H.Radebaugh, and Sullivan, "International Business", New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, "International Business", New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, "International Business", New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, "International Business", New Delhi: Pearson Education, 2020.
5. K.Aswathappa, "International Business", New Delhi: Tata McGraw Hill, 2020.

22EI0XA ELEMENTS OF INDUSTRIAL AUTOMATION 1 0 0 1

Course Objectives

- To provide an extended overview and fundamental knowledge in the field of Industrial Automation, while building the necessary knowledge level for further specialization in advanced concepts of Industrial Automation.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Evaluate the PLC program in different applications.
2. Design a PCB based industrial automation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	1	2
2	-	-	2	2	1	-	-	-	-	-	-	-	1	2

15 Hours

INDUSTRIAL AUTOMATION

Study of advanced automation technologies: Artificial Intelligence, Machine Learning, Digital twin technology and its applications. Hands on: PLC Interfacing with VFD-Hands on: Precision Speed control of VFD using PLC Analog Cards -Hands on: Synchronization of VFD using HMI- Hands on: Level Sensors Pressure sensor to the PLC, Plant Graphic Control Interfacing Program with Monitoring systems.

Total: 15 Hours

Reference(s)

1. Dunning, Gary A. Introduction to programmable logic controllers. Cengage Learning, 2005.
2. Bolton, William. Programmable logic controllers. Newnes, 2015.
3. Rohner, Peter. Automation with programmable logic controllers. UNSW Press, 1996.

4. Adrien Bécue. Artificial intelligence and Industry 4.0: challenges and opportunities. Artificial Intelligence Review, 2021.

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22EI0XB SMART VISUALIZATION OF INDUSTRIAL PARAMETERS 1 0 0 1

Course Objectives

- To explore the smart visualization of industrial parameters.
- To Implementation of augmented reality in instrumentation and developing IoT applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the concepts of augmented reality and digital twin concepts.
2. Implementation of augmented reality/ digital twin concept in instrumentation monitor industrial parameter.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	2	-
2	-	-	2	2	1	-	-	-	-	-	-	-	-	1

15 Hours

INDUSTRIAL PARAMETERS

Introduction to instrumentation, parameters used in industries, sensor identification, and designing, Implementation of Augmented Reality in instrumentation, development, Project development, Introduction to Internet of Things- implementation of Controllers in IoT (general) - Development of logics for simple IoT systems – Introduction to IIoT – Data transmission protocols AR Foundation- Introduction to Unity Software- Setup- Building Application - Visualizing AR planes – Creaing Placement Indicator – Scripting the placement indicator, Communication Technique IoT & Unity Communication Techniques – Implementation of Hardware Handshake Introduction & Implementation of Digital Twin:3 hours Introduction to Digital twin Concept – Industrial Application of digital Twin – Digital twin Development using AR technique Case Studies of Digital Twin: Case study 1- Case Study 2 – Case Study 3.

Total: 15 Hours

Reference(s)

1. Augmented Reality, Sean Morey, John Tinnell Parlor Press LLC, Oct 2016.
2. Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing by Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, Srikanta Pal.

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22EI0XC AUTOMOTIVE EMBEDDED SYSTEM 1 0 0 1

Course Objectives

- To analyze the conceptual design of embedded systems, analog and digital designs.
- To analyze the system testing and its performance in industrial application.
- To understand the communication and testing concepts associated in embedded system development for automotive application.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Evaluate the performance of analog and digital peripherals for MSP430 MCU.
2. Evaluate the performance of embedded systems design and its development for automotive application using MSP430.
3. Analyze the signals of communication protocols in automotive clusters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	-	-	-	-	-	-	-	1
2	1	2	2	2	-	-	-	-	-	-	-	-	-	2
3	1	-	2	-	2	-	-	-	-	-	-	-	-	1

15 Hours

AUTOMOTIVE EMBEDDED SYSTEM

Architecture of an Embedded System- Embedded Hardware and Software Design - Analog control - Digital controllers - Electronic Control Units (ECU), Products Details and Product Roadmap - Automotive Instrumentation Cluster Basics - Introduction to Safety Standards (MISRA) - Understand the communication protocols used in automotive application – Software Verification and Validation - System Testing - Test Case Development from Requirements.

Total: 15 Hours

Reference(s)

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, W Bolton, 3/e, Pearson Edu. Press, 2021.
2. D. Paret, Multiplexed Networks for Embedded Systems, Wiley, 2020.
3. W. Voss, A Comprehensible Guide to Controller Area Network, Copperhill Technologies Corporation, 2018.

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22EI0XD DATA ANALYTICS AND VISUALIZATION **1 0 0 1**

Course Objectives

- Understanding of interoperability in healthcare analytics during the data analytics and visualization.
- Tools and techniques used in summarizing data, its collection, analysis, and processing.
- Know-how of the data interpretation and various techniques used in the process.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Analyze the implications of artificial intelligence on extraction of complex data sets.
2. Interpret data analysis results from a visualization example.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	-	-	2	-	-	1	-	-	-	-
2	-	1	2	2	-	1	-	1	-	-	-	-	-	-

15 Hours

DATA ANALYTICS

Introduction to Tableau - Different Products by Tableau - Advantages of Tableau- Introduction to Data Visualization- Applications of Tableau- Companies using Tableau- Features of Tableau- Tableau Terminologies- Tableau Navigations- Tableau Design Flow- How to Connect to a File Source- Understanding of Different Data Sources- Data Source Filters- Data Types - Tableau Operators- String Functions in Tableau- Date Functions - Logical Statements - Aggregate Functions- Joins- Data Blending- Field Operator-Filter- Changing Data Type of a Field from Data Pane-Formatting- Worksheet- Line Chart- Bar Chart- Histogram- Scatter Plot- Pie Chart- Bubble chart- Tableau Forecasting- Tableau Dashboard.

Total: 15 Hours

Reference(s)

1. Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc.
2. Kumar, R.L., Indrakumari, R., Balamurugan, B., & Shankar, A. (Eds.). (2021). Exploratory Data Analytics for Healthcare (1st ed.). CRC Press.

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22EI0XE AUTOMOTIVE COMMUNICATION PROTOCOLS 1 0 0 1

Course Objectives

- To learn the architecture of the ARM Cortex M4 microcontroller.
- To create the programming in embedded automotive communication protocols.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Apply the comprehensive knowledge of the STM32F405 microcontroller and its peripherals.
2. Create the programming and interfacing various components and communication protocols for embedded systems development.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	2	-	-	-	2	-	-	1	1	2
2	3	3	2	3	2	-	-	-	2	-	-	1	1	2

20 Hours

COMMUNICATION PROTOCOLS

Introduction to Auto Edge Development board - introduction to STM32F405 – architecture – memory map – phase locked loop – CAN protocol – Frame Formats of CAN –message filtering- Introduction to LIN– LIN network communication - Introduction to UDS, Service ID's, NRC – Basic working of OBD - Onboard Diagnostics and the necessity of OBD in Automotive Engineering - Onboard Diagnostics Apps.

Total: 20 Hours

Reference(s)

1. STMicroelectronics. User manual STM32 value line discovery, 2010. UM0919.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. STMicroelectronics. Programming manual: Stm32f10xxx/ 20xxx/ 21xxx/l1xxxxcortex-m3programmingmanual, March 2011.PM0056.
4. STMicroelectronics. Low & medium-densityvalueline, advancedARMbased32 bitMCUwith16to128kbflash, 12timers, ADC, DAC&8 comminterfaces, 2011.DocID16455.

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22EI0XF ADVANCED STM32 ARM PROGRAMMING TECHNIQUES 1 0 0 1

Course Objectives

- To learn the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
- To learn STM ARM Internal Peripherals Programming and Communication Protocols.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Outline the STM32 32-Bit Microcontroller and STM32 ARM I/O Programming.
2. Outline the STM ARM Internal Peripherals Programming and CAN Communication Protocols.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	2	-	-	-	2	-	-	1	1	2
2	3	3	2	3	2	-	-	-	2	-	-	1	1	2

5 Hours

INTRODUCTION TO STM32 32-BIT MICROCONTROLLER

Introduction to Microcontroller – Von Neumann and Harvard architecture – RISC vs CSIC- Explore the STM32F series, covering its key features, architecture, functional overview, Memory organization-Memory Map, pinout, and pin descriptions. Gain insights into the electrical characteristics of STM32 integrated circuits.

STM32 ARM I/O PROGRAMMING **5 Hours**

Dive into GPIO and I/O programming, along with interfacing techniques for relays, optoisolators, and limit switches.

STM ARM INTERNAL PERIPHERALS PROGRAMMING **5 Hours**

Timers and counters, covering timer and delay generation, compare register, waveform output, timer input capture, and PWM. Explore PWM applications in electric vehicle scenarios- ADC characteristics and programming with STM32 ARM, including interfacing with position sensors- DAC applications and the programming of DAC for various functionalities.

COMMUNICATION PROTOCOLS **5 Hours**

CAN protocol, covering frame formats, understanding CAN nodes, signaling, bus states, bit timing calculation, and networking with transceivers. Explore the bxCAN peripheral of STM32, including self-testing modes and block diagrams- UART, its functionality, and programming aspects- SPI, its working principles, and programming with a focus on interfacing with MEMS accelerometer sensors.

Total: 20 Hours

Reference(s)

1. Embedded Systems: ARM Programming and Optimization by Jason D. Bakos, 2nd Edition, Elsevier, 2023.
2. A Review of Embedded Automotive Protocols, by Nicolas Navet, Françoise Simonot-Lion, 1st Edition, CRC Press, 2009.
3. Embedded System Design with ARM Cortex-M Microcontrollers: Applications with C, C++ and MicroPython by Cem Ünsalan , Hüseyin Deniz Gürhan , Mehmet Erkin Yücel, Springer, 2022.

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22EI0XG INTELLIGENT SENSOR DESIGN **1 0 0 1**

Course Objectives

- Conceptualize the application and working principle of intelligent sensors for measuring physical and electrical parameters used in industrial automation.
- Installing, troubleshooting, and maintaining industrial automated and electrical production systems using Intelligent Sensor.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.
PSO2.Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Analyze the performance of 1D, 2D and QR code identification sensors in the span of low frequency to ultra- high frequency speed.
2. Apply the industrial parameters such as displacement, distance, pressure, level and flow using smart sensors in terms of industrial standards.
3. Analyze the rate of pollution in the industrial environment using Dust Measurement Device.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	2	-	2	-	-	-	-	-	2	3
2	3	3	2	-	2	-	2	-	-	-	-	-	2	3

20 Hours

SENSOR DESIGN

Presence Absence detection- Presence Detection - Belt conveyor with Sensors- Smart Industrial Instrumentation Level, Pressure and Flow Sensors Industry 4.0 – Working demonstration of I4.0 with JSON Commands, Motion control sensors – Encoders - Rotary/Absolute/Programmable - Identification Kit- 1D/2D Barcodes, RFID Tags Identification - Robot Cell Area Guarding Demo Kit using DeTec4 Safety Light Curtains.

Hands-on Training: 2D Vision Kit with Smart Camera- OCR Reading and Quality Inspection - 3D Vision camera -Long Distance Measurement Sensor Kit - Displacement Measurement Kit- LiDAR Scanner for Anti-collision on Mobile car - Safety Functionality Simplified - Demo Kit - Area Guarding with Safety Laser Scanner Kit - Dust Measurement Device for Continuous Emission Measurement

Total: 20 Hours

Reference(s)

1. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, Smart sensors for industrial internet of things, Springer International Publishing, 2021.
2. Sick Sensor Materials

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