B.E. (MECHATRONICS 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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CONTENTS

VISION OF THE DEPARTMENT

To prepare students to achieve academic excellence in Mechatronics education with a practically oriented curriculum, research and innovative product development.

MISSION OF THE DEPARTMENT

1. To provide pedagogical expertise to disseminate technical knowledge.
2. To foster continuous learning and research by establishing state of the art facilities.
3. To provide exposure to latest technologies through industry-institute interaction.
4. To nurture the innovation to develop interdisciplinary projects

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To impart adequate technical knowledge and skills in the area of mechanical, electrical and electronic systems to solve problems pertaining to mechatronics

II. To adapt multidisciplinary approach for product design, development and manufacturing using contemporary tools.

III. To exhibit research aptitude and life-long learning in the working environment with professional and ethical responsibility.

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 analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, naturalsciences, 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 ofthe 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 ones 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.

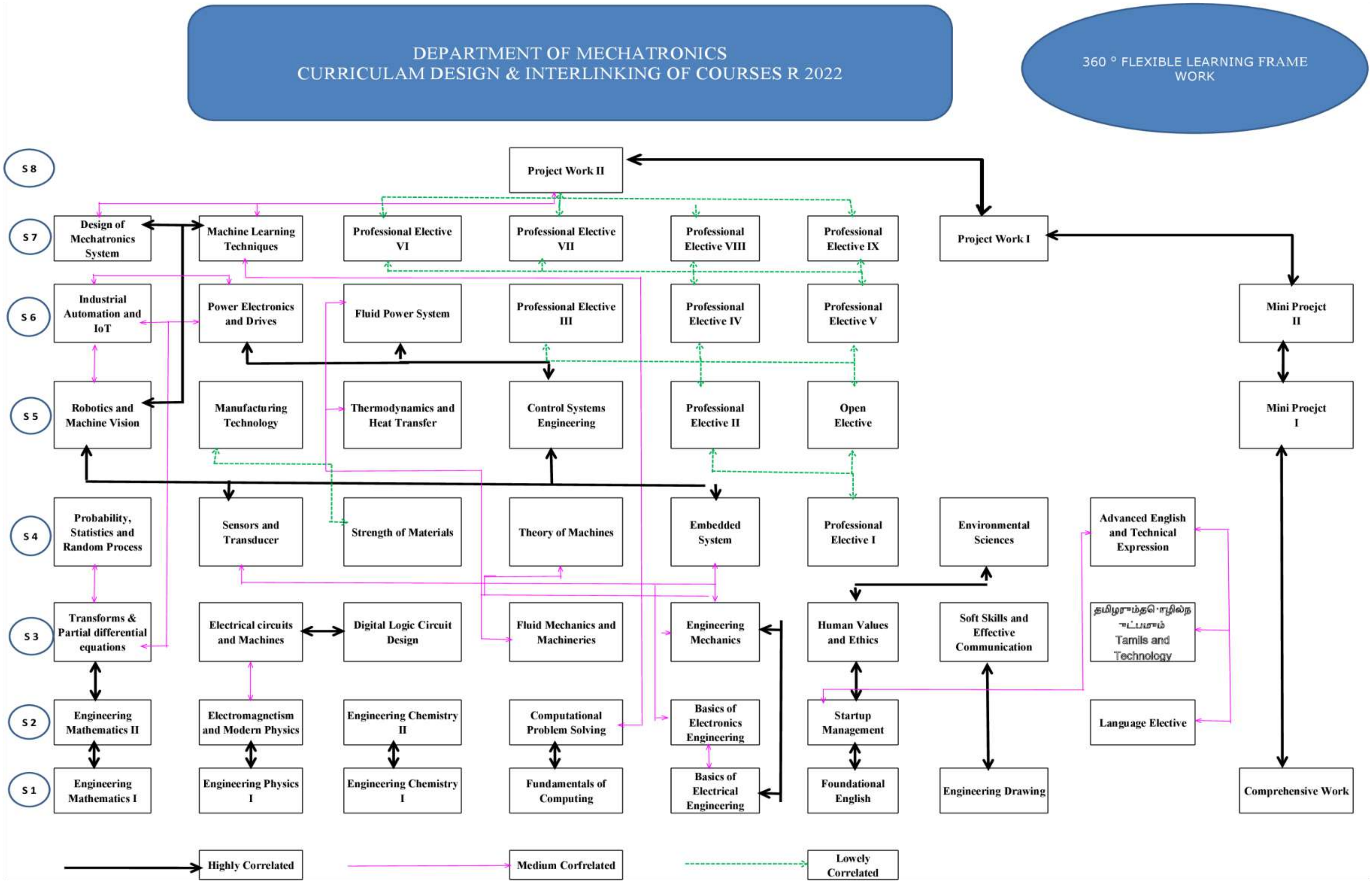
PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools

2. Perform multidisciplinary activities in the mechatronics systems to solve real world problem.

MAPPING OF PEOs AND Pos

POs	a	b	c	d	e	f	g	h	i	j	k	l	PSO 1	PSO 2
PEO1	X	X	-	-	-	-	-	-	-	-	-	-	X	X
PEO2	-	-	X	X	X	-	X	-	-	-	-	-	X	X
PEO3	-	-	-	-	-	X	-	X	X	X	X	X	-	X


DEPARTMENT OF MECHATRONICS
CURRICULAM DESIGN & INTERLINKING OF COURSES R 2022
360 ° FLEXIBLE LEARNING FRAME WORK
S 8
Project Work II
S 7
Design of Mechatronics System
Machine Learning Techniques
Professional Elective VI
Professional Elective VII
Professional Elective VIII
Professional Elective IX
Project Work I
S 6
Industrial Automation and IoT
Power Electronics and Drives
Fluid Power System
Professional Elective III
Professional Elective IV
Professional Elective V
Mini Proejct II
S 5
Robotics and Machine Vision
Manufacturing Technology
Thermodynamics and Heat Transfer
Control Systems Engineering
Professional Elective II
Open Elective
Mini Proejct I
S 4
Probability, Statistics and Random Process
Sensors and Transducer
Strength of Materials
Theory of Machines
Embedded System
Professional Elective I
Environmental Sciences
Advanced English and Technical Expression
S 3
Transforms & Partial differential equations
Electrical circuits and Machines
Digital Logic Circuit Design
Fluid Mechanics and Machineries
Engineering Mechanics
Human Values and Ethics
Soft Skills and Effective Communication
Tamils and Technology
S 2
Engineering Mathematics II
Electromagnetism and Modern Physics
Engineering Chemistry II
Computational Problem Solving
Basics of Electronics Engineering
Startup Management
Language Elective
S 1
Engineering Mathematics I
Engineering Physics I
Engineering Chemistry I
Fundamentals of Computing
Basics of Electrical Engineering
Foundational English
Engineering Drawing
Comprehensive Work
Highly Correlated
Medium Corfrelated
Lowely Correlated

DEPARTMENT: Mechatronics Engineering Minimum Credits to be Earned : 165										
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
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	50	50	100	HSS
22GE005	ENGINEERING DRAWING	1	0	2	2	3	50	50	100	ES
22HS003	தமிழர் மரபு HERITAGE OF TAMILS#*	1	0	0	1	1	40	60	100	HSS
22MC108	COMPREHENSIVE WORK$	0	0	2	1$	2	100	0	100	EEC
Total		**14**	**1**	**12**	**21**	**27**	-	-	-	-
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
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	50	50	100	EEC
-	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*	0	0	2	NC	2	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	
22MC301	TRANSFORMS AND PARTIAL DIFFERENTIAL	3	1	0	4	4	40	60	100	ES
22MC302	ELECTRICAL CIRCUITS AND MACHINES	3	1	0	4	4	40	60	100	PC
22MC303	DIGITAL LOGIC CIRCUIT DESIGN	3	0	2	4	4	50	50	100	PC
22MC304	FLUID MECHANICS AND MACHINERY	3	0	2	4	5	50	50	100	PC
22MC305	ENGINEERING MECHANICS	3	1	0	4	4	40	60	100	ES
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	1	60	40	100	HSS
Total		**17**	**3**	**6**	**23**	**26**	-	-	-	-

IV SEMESTER

Code No.	Course	L	T	P	C	Hours / Week	Maximum Marks			Category
							CIA	SEE	Total	
22MC401	PROBABILITY, STATISTICS AND RANDOM PROCESS	3	1	0	4	4	40	60	100	ES
22MC402	SENSORS AND TRANSDUCER	3	0	2	4	5	50	50	100	PC
22MC403	STRENGTH OF MATERIALS	2	1	2	4	5	50	50	100	PC
22MC404	THEORY OF MACHINES	3	0	2	4	5	50	50	100	PC
22MC405	EMBEDDED SYSTEM	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	-	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	60	40	100	HSS
22HS010	SOCIALLY RELEVANT PROJECT*	0	0	2	NC	2	100	-	100	HSS
Total		**19**	**2**	**10**	**24**	**31**	-	-	-	-

* 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	
22MC501	ROBOTICS AND MACHINE VISION	2	1	2	4	5	50	50	100	PC
22MC502	MANUFACTURING TECHNOLOGY*	3	0	2	4	4	50	50	100	PC
22MC503	THERMODYNAMICS AND HEAT TRANSFER	3	0	2	4	5	50	50	100	PC
22MC504	CONTROL SYSTEMS ENGINEERING	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
22MC507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
Total		**16**	**2**	**8**	**23**	**27**	-	-	-	-

VI SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MC601	INDUSTRIAL AUTOMATION AND IoT	3	0	2	4	5	50	50	100	PC
22MC602	POWER ELECTRONICS AND DRIVES	3	0	2	4	5	50	50	100	PC
22MC603	FLUID POWER SYSTEM	2	1	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
22MC607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**17**	**1**	**8**	**22**	**26**	-	-	-	-

* LTPC for this course is 2 0 2 3 for the students admitted during academic year 2022-2023.

VII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MC701	DESIGN OF MECHATRONICS SYSTEM	3	0	2	4	5	50	50	100	ES
22MC702	MACHINE LEARNING TECHNIQUES	3	0	0	3	3	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
22MC707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**18**	**0**	**6**	**21**	**24**	-	-	-	-

VIII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MC801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total		0	0	20	**10**	**20**	-	-	-	-

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
22HSC01	CHINESE	1	0	2	2	3	50	50	100	HSS
22HSF01	FRENCH	1	0	2	2	3	50	50	100	HSS
PROFESSIONAL ELECTIVES										
VERTICAL I – APPLIED ROBOTICS										
22MC001	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
22MC002	ROBOT CONTROL USING ROS	3	0	0	3	3	40	60	100	PE
22MC003	DRONE TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22MC004	ROBOTIC VISION	3	0	0	3	3	40	60	100	PE
22MC005	MEDICAL ROBOTICS	3	0	0	3	3	40	60	100	PE
22MC006	MOBILE ROBOTICS	3	0	0	3	3	40	60	100	PE
VERTICAL II – DESIGN AND MANUFACTURING										
22MC007	CNC TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22MC008	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	40	60	100	PE
22MC009	ADDITIVE MANUFACTURING	3	0	0	3	3	40	60	100	PE
22MC010	NON -DESTRUCTIVE TESTING	3	0	0	3	3	40	60	100	PE
22MC011	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3	3	40	60	100	PE
22MC012	INDUSTRIAL ENGINEERING	3	0	0	3	3	40	60	100	PE
VERTICAL III – SMART MOBILITY										
22MC013	ELECTRIC AND HYBRID VEHICLES	3	0	0	3	3	40	60	100	PE
22MC014	AUTONOMOUS AND CONNECTED VEHICLES	3	0	0	3	3	40	60	100	PE
22MC015	AUTOMOTIVE INFOTRONICS	3	0	0	3	3	40	60	100	PE
22MC016	AUTOMOTIVE COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	PE
22MC017	VEHICLE CONTROL SYSTEMS	3	0	0	3	3	40	60	100	PE
22MC018	MACHINE LEARNING FOR AUTONOMOUS VEHICLES	3	0	0	3	3	40	60	100	PE

VERTICAL IV – INTELLIGENT SYSTEMS										
22MC019	APPLIED IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
22MC020	FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORK	3	0	0	3	3	40	60	100	PE
22MC021	ARTIFICIAL INTELLIGENCE	3	0	0	3	3	40	60	100	PE
22MC022	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22MC023	SOFT COMPUTING	3	0	0	3	3	40	60	100	PE
22MC024	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
VERTICAL V – AUTOMATION										
22MC025	MEDICAL MECHATRONICS	3	0	0	3	3	40	60	100	PE
22MC026	VIRTUAL INSTRUMENTATION APPLICATIONS	3	0	0	3	3	40	60	100	PE
22MC027	INDUSTRIAL DRIVES AND CONTROL	3	0	0	3	3	40	60	100	PE
22MC028	CONTROL SYSTEM AND DRIVES FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22MC029	PROCESS CONTROL	3	0	0	3	3	40	60	100	PE
22MC030	ADVANCED INDUSTRIAL AUTOMATION	3	0	0	3	3	40	60	100	PE
VERTICAL VI – SENSOR TECHNOLOGIES AND IoT										
22MC031	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22MC032	INDUSTRIAL PROCESSORS	3	0	0	3	3	40	60	100	PE
22MC033	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22MC034	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22MC035	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22MC036	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE
HONOURS VERTICAL COURSES - APPLIED ROBOTICS *										
22MCH01	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
22MCH02	ROBOT CONTROL USING ROS	3	0	0	3	3	40	60	100	PE
22MCH03	DRONE TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22MCH04	ROBOTIC VISION	3	0	0	3	3	40	60	100	PE
22MCH05	MEDICAL ROBOTICS	3	0	0	3	3	40	60	100	PE
22MCH06	MOBILE ROBOTICS	3	0	0	3	3	40	60	100	PE

* Honor 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
22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
22OEC01	BASICS OF ANALOG AND DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	OE
22OEC02	MICROCONTROLLER PROGRAMMING	3	0	0	3	3	40	60	100	OE
22OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	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
22OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE
22OEI02	SENSOR TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	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 OIL SEED 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
22OPH02	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	OE
22OPH03	APPLIED LASER 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

ONE CREDIT COURSES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22MC0XA	EMBEDDED MODBUS CONTROL FOR INDUSTRIAL DRIVE CONFIGURATION	1	0	0	1	-	100	0	100	EEC
22MC0XB	DRONE DESIGN TECHNIQUES	1	0	0	1	-	100	0	100	EEC
22MC0XC	ENGINE AND VEHICLE ELECTRONICS SYSTEMS	1	0	0	1	-	100	0	100	EEC
22MC0XD	ADVANCED LORAWAN-ENA BLEDIoTRevolutionizingSmartTechnology	1	0	0	1	-	100	0	100	EEC
22MC0XE	SYNERGISTIC PARTNERSHIPS: INTEGRATING HUMANS AND ROBOTS IN INDUSTRY 4.0	1	0	0	1	-	100	0	100	EEC

SUMMARY OF CREDIT DISTRIBUTION

S. No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in%	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	-	-	-	-	-	-	20	12%	15%	20%
2	ES	8	6	8	4	-	-	4	-	30	18%	15%	20%
3	HSS	2	2	3	1	-	-	-	-	8	5%	5%	10%
4	PC	-	-	12	16	16	12	3	-	59	36%	30%	40%
5	PE	-	-	-	3	6	9	12	-	30	18%	15%	20%
6	EEC	1	3	-	-	1	1	2	10	18	11%	7%	10%
Total		21	21	23	24	23	22	21	10	165	100%	-	-

BS - Basic Sciences
ES – Engineering Sciences
HSS – Humanities and Social Sciences PC - Professional Core
PE - Professional Elective
EEC – Employability Enhancement Course
CA - Continuous Assessment
ES – End Semester Examination

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

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	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	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 - Orhtogonality - 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, Taylors 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 decline - Exponential equations have a variable as an exponent and take the form y = abx 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, 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 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.

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. Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Illustrate the concept and principles of energy to understand mechanical systems
2. Exemplify the types of mechanical oscillations based on vibrational energy
3. Infer the concept of propagation of energy as 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	2	-
2	3	2	1	2	-	-	-	-	2	-	-	1	2	-
3	3	2	2	1	-	-	-	-	2	-	-	1	2	-
4	3	2	2	1	-	-	-	-	2	-	-	1	2	-
5	3	2	2	1	-	-	-	-	2	-	-	1	2	-

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 Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Understand nuclear transmutation reactions that lead to the formation of elements in the universe
2. Illustrate atomic structure of elements in the periodic table and 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	-	-	-	-	-	-	-	-	-	-	1	-
2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
3	2	1	-	-	-	-	-	-	-	-	-	-	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 plant 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

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

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.

11 Hours

UNIT III

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

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Interpret 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. Interpret 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	-	-	-	-	-	3	-	-	-	3	-
2	2	2	2	-	-	-	-	-	-	-	-	3	-	-
3	3	3	2	-	3	-	-	-	-	-	-	-	-	-
4	2	2	2	3	-	-	-	-	-	3	-	-	-	-
5	1	2	1	3	-	-	3	-	-	3	-	-	3	-

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.

15 Hours

EXPERIMENT 1

Analyze and design of Electromechanical energy conversion system.

15 Hours

EXPERIMENT 2

Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

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

22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

Course Objectives

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential and reading fluency in formal and informal contexts
- Prowess and develop abilities as critical readers and writers in interpreting complex texts.

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand 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- Paralinguistic / Vocalic- 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 forIntermediate 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 IGCSEA, First Language English. 2018th ed., HodderEducation, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervisionand Curriculum Development, 2008.

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. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO5. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

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

22HS003 HERITAGE OF TAMILS 1 0 0 1

Course Objectives

1. Describe the linguistic diversity in India, highlighting Dravidian languages and their features.
2. Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures.
3. Examine the role of sports and games in promoting cultural values and community bonding.
4. Discuss the education and literacy systems during the Sangam Age and their impact.
5. 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	3	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-

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, Leather puppetry, 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 திரொவிடதமொழிகள்தனித்F 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 ததொடங்கி, இக்கொலம் வமர சிற்பக்கமல அமடந்த வளர்ச்சிமய கண்டுதகொள்ளல் .
6. தமிழர் தம் வொழ்வில் எங்கனம் இயற்மகமய வணங்கி பபொற்றினர் 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

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

UNIT I **9 Hours**

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs 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 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, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,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 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.

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.

Course Outcomes (COs)

1. Understand the principles and mechanism of electrostatics and current
2. Illustrate the principles and mechanism of magnetostatics
3. Classify electromagnetic waves and infer the characteristics of visible light
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Exemplify the electrical properties of semiconductor based on the band theory

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	-
2	3	2	1	2	-	-	-	-	2	-	-	1	-	-
3	3	2	2	1	-	-	-	-	2	-	-	1	-	-
4	3	2	2	1	-	-	-	-	2	-	-	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
1. 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.

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. Understand the mechanism of corrosion and suggest a method to control the corrosion
4. Illustrate 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	2	1	-	-	-	-	-	-	-	-	-	-	2	-
3	2	1	-	-	-	-	1	-	-	-	-	-	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
5	2	1	-	-	-	-	-	-	-	-	-	-	2	-

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.

LABORATORY EXPERIMENTS

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

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

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. 1.Understand the need for electrical and electromagnetic signal transmission.
2. 2.Analyze the working principle and characteristics of PN junction diode.
3. 3.Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. 4.Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. 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	2	2	-	-	-	-	-	3	-	-	-	3	-
2	2	2	2	-	-	-	-	-	-	-	-	3	-	-
3	3	3	2	-	3	-	-	-	-	-	-	-	-	-
4	2	2	2	3	-	-	-	-	-	3	-	-	-	-
5	1	2	1	3	-	-	3	-	-	3	-	-	3	-

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.

6 Hours

EXPERIMENT 1

Implement a morse code generator using basic electronic components and Arduino using wired and wireless methods.

EXPERIMENT 2

Design and construct regulated DC power supply for Mobile phone charger

6 Hours

EXPERIMENT 3

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

6 Hours

EXPERIMENT 4

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

6 Hours

EXPERIMENT 5

Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

otal: 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)

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
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering

Programme Outcomes (POs)

PO2. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

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

1 Hours

EXPERIMENT 1

Analysis of various business sectors

1 Hours

EXPERIMENT 2

Developing a Design Thinking Output Chart

1 Hours

EXPERIMENT 3

Creating Buyer Personas

2 Hours

EXPERIMENT 4

Undertake Market Study to understand market needs and assess market potential

2 Hours

EXPERIMENT 5
Preparation of Business Model Canvas

2 Hours

EXPERIMENT 6
Developing Prototypes

2 Hours

EXPERIMENT 7
Organizing Product Design Sprints

2 Hours

EXPERIMENT 8
Preparation of Business Plans

2 Hours

EXPERIMENT 9
Preparation of Pitch Decks

15 Hours

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 Proper1ty, Eastern Book Company, 2nd Edition, 2021

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 & 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 & TAMIL COMPUTING

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
5. Institute of Tamil Studies
6. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' , Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
7. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
8. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
9. R.Balakrishnan , Journey of Civilization Indus to Vaigai, RMRL

22HS006 - தமிழரும் ததாழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் ந ோக்கம்

- சங்க கொலத்தில் வரலொறு மற்றும் கலொச்சொர ஆவணங்களின் ஒரு வடிவமொக, மட்பொண்டங்கள் மீததொன கிரொஃபிட்டிமய பகுப்பொய்வு தசய்தல்.
- சிலப்பதிகொரத்தில் கட்டப்பட்ட பமமட கட்டுமொனங்களின் விவரங்கமளயும் அவற்றின் கலொச்சொர முக்கியத்Fவத்மதயும் பகுப்பொய்வு தசய்வதன் மூலம், சங்க கொலத்தில் மொவீரர் கற்களின் கட்டுமொனப் தபொருட்கள் மற்றும் வரலொற்று சூழமல ஆரொய்தல்.
- 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

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) (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 / EXTRACURRICULAR ACTIVITIES L T P C
0 0 2 -

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 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

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.

Course Outcomes (COs)

The students will be able to

CO1 Build leadership skills and teamwork capabilities by engaging in group activities through organization and participation of events

CO2 Demonstrate the technical, creative, and interpersonal skills through active participation in technical events.

CO3 Exhibit balanced academics with diverse cultural, sports, and literary activities, showcasing improved time management and organizational skills.

CO4 Enhance the social responsibility and community engagement by participating in outreach and extension activities.

CO5 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

22MC301 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Recognize 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. Formulate a function in frequency domain whenever the function is defined in time domain through Laplace transforms.
4. Use Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Understand 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	1	2	-	-	-	-	-	-	-	-	-	-	2	-
2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
3	1	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

FOURIER SERIES

Introduction-Periodic functions-Dirichlets conditions - General Fourier series - Odd and even functions - Parsevals 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 - Parsevals 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 (clairauts 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, 7th Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Pearson, 3rd edition 2014.
4. Michael D Greenberg., Advanced Engineering Mathematics, Pearson Education, 2nd Edition 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2015.

22MC302 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Understand the fundamental laws to electric circuits and compute the different alternating quantities.
2. Analyze the resonance frequency, bandwidth, Q factor and RL, RC response time constants.
3. Compare the excitation and magnetization characteristics of DC Machines.
4. Compute the essential parameters for slip-speed characteristics of induction motor.
5. Identify the special electrical machines for specified application.

Articulation Matrix

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

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

22MC303 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.Course

Outcomes (COs)

1. Analyze the weighted, non-weighted number systems and Codes
2. Analyze the boolean laws and K-Map for minimization of logic circuits
3. Design and analyze the combinational logic circuits
4. Design and analyze the sequential logic circuits
5. Design and analyze the synchronous & asynchronous counters, logic families and Programmable Logic Devices (PLDs)

Articulation Matrix

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

22MC304 FLUID MECHANICS AND MACHINERY 3 0 2 4

Course Objectives

- To impart knowledge on the fluid properties and fluid statics principles
- To introduce the basic concept of fluid kinematics and dynamics
- To calculate the rate of flow and energy losses in flow through pipes and open channels
- To emphasize the concepts of boundary layer theory and the importance of dimensional analysis
- To impart the knowledge of pumps and turbines

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
PO5. 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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Explain the fundamental properties of fluids and methods of pressure measurement in fluid statics
2. Infer fundamentals of fluid kinematics and dynamics and their applications in hydraulic experiments
3. Apply the concept of the boundary layer, Dimensional analysis, and Modal analysis to the fluid structures
4. Assess the performance of a model by dimensional analysis and similitude
5. Compute the efficiency and performance of pumps and turbines

Articulation Matrix

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

9 Hours

UNIT I
FLUID PROPERTIES AND FLUID STATICS
Concept of Continuum, Properties of Fluid, Classification of fluids, Types of fluid flow Streamline, Streamlines, and path line, Pascals Law and Hydrostatic Law, Pressure and its variation in a static Fluid, Measurement of fluid pressure Manometers, Buoyancy and meta-Centre, Stability analysis and applications

UNIT II **8 Hours**
FLUID KINEMATICS AND DYNAMICS
Continuity equation, Velocity Potential and Stream function, Bernoullis equation, and its applications, Impulse - Momentum principle, Impact of Jet, Velocity triangle

UNIT III **9 Hours**
FLOW THROUGH PIPES AND CHANNELS
Laminar and turbulent flows in circular pipes, Major and Minor losses in pipes, Darcy Weisbach equation, Hagen Poiseuille equation, Multi reservoir problems, pipe network design, Types of open Channel flows, Measurement of discharge in open channels, Notches, Most economical channel section.

UNIT IV **9 Hours**
DIMENSIONAL ANALYSIS AND MODEL TESTING
Buckinghams pitheorem and Application of theorem in fluid flow Reynolds, Froude, and Mach number and their applications in model testing, Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of the boundary layer, and Methods of preventing the boundary layer separation

UNIT V **10 Hours**
HYDRAULIC MACHINES
Centrifugal pumps, Work done, Head developed, Pump output and Efficiencies, priming - minimum starting speed, performance of multistage pumps, Cavitation, methods of prevention, Pump characteristics, Classification of hydraulic turbines, Pelton wheel, Francis turbine, Kaplan and turbines, Specific speed, Performance characteristics, Selection of turbines, Turbine efficiencies

EXPERIMENT 1 **6 Hours**
Find the coefficient of discharge by suitable device that is most accurate to measure the fuel and air distribution in the carburetor of an IC engine in a two wheeler Also, in Pasteurization and Sterilization process. Discuss the effects of the Reynolds number and friction factor in relation to the rate of flow

EXPERIMENT 2 **3 Hours**
Analyze the friction factor of various pipes in a distribution of a water supply for domestic applications

EXPERIMENT 3 **3 Hours**

Determine the coefficient of discharge by suitable device used to monitor and control the flow of water and chemicals in water treatment plants

EXPERIMENT 4 **3 Hours**

Analyze the Lift and drag force of an aerofoil design used in a windmill for power generation

EXPERIMENT 5 **3 Hours**

Conduct the performance test of a suitable turbine that is used to extract energy from waterfalls whose water drops down from a height of about 500 m to generate power in Hydropower station

EXPERIMENT 6

6 Hours

Conduct the test from which electricity is to be generated has its reservoir fully filled up during the rainy season and the level drops down during summer. A turbine has to be put up such that it can accommodate both cases in a hydropower station.

EXPERIMENT 7 **6 Hours**

Determine the efficiency of a pump to pump water to a very high elevation, say >300 ft, and high viscous fluid used for an irrigation and Chocolate Industry.

Total: 75 Hours

Reference(s)

1. Yunus A Cengel, and John M Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt Ltd, 2014
2. Dr R.K. Bansal , A textbook of Fluid Mechanics and Hydraulic Machines, Tenth Edition, LaxmiPublications, New Delhi, 2018
3. Frank M White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition 2017
4. R C Hibbler, Fluid Mechanics, Pearson, First edition, 2017
5. S K Som and G Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education 2017
6. https://nptel.ac.in/courses/112105183

22MC305 ENGINEERING MECHANICS 3 1 0 4

Course Objectives

- To make the students apply static equilibrium of rigid bodies both in two dimensions and also in three dimensions.
- To comprehend the effect of friction on equilibrium.
- To understand the geometrical properties of surfaces and solids.
- To understand various terms involved in Projectiles.
- To apply dynamic equilibrium of particles in solving basic problems.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Explain the different principles of mechanics and to solve engineering problems dealing with forces.
2. Apply the concepts of friction to solve various problems dealing with friction.
3. Explain the different geometrical properties of various sections.
4. Solve problems in rigid body dynamics (kinematic systems).
5. Solve problems in rigid body dynamics (kinetic systems).

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MECHANICS AND FORCE CONCEPTS

Principles and Concepts - Laws of mechanics - system of forces - resultant of a force system - Lamis theorem - moment of a force - Varignons theorem - resolution of a force into force and couple - force in space - equilibrium of a particle in space.

UNIT II **9 Hours**

BASIC STRUCTURAL ANALYSIS AND FRICTION

Beams and types of beams - Simple Trusses - Method of Joints - Method of Sections. Friction resistance - classification of friction - laws of friction - angle of repose - cone of friction - free body diagram - equilibrium of a body on a rough inclined plane - non concurrent force system - ladder friction - rope friction - wedge friction - virtual work method.

9 Hours

UNIT III

GEOMETRICAL PROPERTIES OF SECTION

Centroids - determination by integration - moment of inertia - product of inertia - principal moment of inertia of plane areas - radius of gyration - Mass moment inertia of simple solids.

UNIT IV **9 Hours**

BASICS OF DYNAMICS - KINEMATICS

Kinematics and kinetics - displacements, velocity and acceleration - equations of motion - rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration - curvilinear motion of particles - projectiles - angle of projection - range - time of flight and maximum height - kinematics of rigid bodies.

UNIT V **9 Hours**

BASICS OF DYNAMICS - KINETICS

Newtons second law of motion - DAlemberts principle, dynamics equilibrium - work energy equation of particles - law of conservation of energy - principle of work and energy. Principles of impulse and momentum - equations of momentum - laws of conservation of momentum. Impact - time of compression, restitution, collision - co-efficient of restitution - collision of elastic bodies by direct central impact and oblique impact - collision of small body with a massive body - kinetic energy of a particle-kinetics of rigid body rotation.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Beer F.P and Johnston Jr. E.R, Vector Mechanics for Engineers (In SI Units): Statics and Dynamics, 11th Edition, Tata McGraw Hill Publishing company, New Delhi, 2017.
2. Bhavikatti S. S. and Rajashekarappa, K.G, Engineering Mechanics, New Age International (P) Limited Publishers, 2021.
3. Hibbeller, R.C and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Edition, Pearson Education 2010.
4. Irving H. Shames and Krishna MohanaRao. G., Engineering Mechanics - Statics and Dynamics, 4th Edition, Pearson Education, 2006.
5. Meriam J. L. and Kraige L. G, Engineering Mechanics- Statics - Volume 1, DynamicsVolume 2, 5th Edition, John Wiley & Sons,2006.
6. www.nptel.iitm.ac.in/video.php?subjectId=122104015

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

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 the 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 in formal discussions at the workplace efficaciously and proficiently.
- Describe experiences and events, and briefly give reasons and explanations for opinions andplans.
- Convey agreement and disagreement in a polite but firm manner in both written and spoken formats.

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. Enhance confidence in expressing thoughts in grammatically proper language and etiquette inwaiting for the opportunity to provide input.
2. Effectively communicate in English on formal occasions and proficiency in the use of linkwords 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 - SELF-EXPRESSION 10 Hours

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 - CREATIVE EXPRESSION **10 Hours**

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

UNIT – III - FORMAL EXPRESSION **10 Hours**

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 forIntermediate 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, BarunK.Mitra, Oxford University Press, 2012
6. Business English by Ken Taylor, Orient Blackswan, 2011

22MC401 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

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	-	3	-	-	-	2	-	-	-	-	2	-
2	1	2	-	2	-	-	-	2	-	-	-	-	2	-
3	1	2	-	2	-	-	-	2	-	-	-	-	2	-
4	1	2	-	2	-	-	-	2	-	-	-	-	2	-
5	1	2	-	3	-	-	-	2	-	-	-	-	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, Tata McGraw Hill Publications, New Delhi, 4th Edition, 2010.
2. Richard A Johnson and John Freund, Miller and Freunds Probability Statistics for Engineers, 8th Edition, Pearson Education, 2015
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education, Delhi, 3rd Edition, 2002
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability , Random Variables and Stochastic Processes, Tata McGraw Hill Publications, New Delhi, 4th Edition , 2010

22MC402 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.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Examine the type of errors, characteristics and mathematical model of a transducer
2. Apply the characteristics of variable resistive transducer in a given application
3. Analyze the principles of variable inductive transducer
4. Characterize the different capacitive transducers for the measurement of physical quantities
5. Identify 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	2	2	3	-	-	-	-	-	-	-	-	-	2	2
2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	3	-	-	-	-	-	-	-	-	-	2	2
4	2	2	-	3	-	-	-	-	-	-	-	-	-	2
5	1	2	3	-	-	-	-	-	-	-	-	-	-	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 - Piezoresistive 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, PuneetSawhney, 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.

22MC403 STRENGTH OF MATERIALS 2 1 2 4

Course Objectives

- To provide knowledge about stress structures subjected to axial and thermal loads
- To familiarize about two-dimensional stress systems and theories of failure
- To construct shear force, bending moment diagrams and evaluate the bending stress in beams under transverse loading
- To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions
- To provide awareness on stresses on shafts and helical springs based on theory of torsion

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. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Find the stress distribution and strains in regular and composite structures subjected to axial loads.
2. Evaluate the compound stresses in two dimensional systems and thin cylinders
3. Assess the shear force, bending moment and bending stresses in beams under transverse loading
4. Evaluate the slope and deflection of beams and buckling loads of columns under different boundary conditions
5. Apply torsion equation in design of circular shafts and helical springs

Articulation Matrix

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

UNIT I **6 Hours**

SIMPLE STRESS AND STRAIN

Mechanical properties of Materials. Stress-strain curve - Factor of safety. Strain Energy and Impact Loading. Stepped and Composite bars - Axial Stresses, Thermal Stress and Volumetric Stresses - Elastic constants and their relationship.

UNIT II **6 Hours**

COMPOUND STRESSES AND THIN CYLINDER

State of stresses at a point, 2D Stress System, Plane Stress Condition, Mohr s circle. Thin Cylinders - Stresses, Strain, Maximum Shear stress, Changes in dimensions and volume. Theories of Failure - Significance and Graphical Representations

UNIT III **6 Hours**

SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS

Beams - Types of supports, loads and beams, Shear force and Bending Moment in Cantilever, simply supported and overhanging beams, Point of contra flexure. Theory of Simple Bending, Section modulus, Bending stress and stress variation along the length and section of the beam

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay"s method. Theory of Columns - Slenderness ratio, End Conditions, Equivalent length, Euler and Rankine"s formulae.

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Theory of Torsion, Stresses and Deformations in Solid and Hollow Circular Shafts, Combined bending moment and torsion of shafts, Power transmitted to shaft, Shaft in series and parallel. Close coiled helical spring - Stresses, deflection, Maximum shear stress in spring section including Wahl"s Factor, springs in series and parallel

EXPERIMENT 1 **6 Hours**

Assess the hardness of material to be used as brake shoe in bicycles to give long life with minimum wear

EXPERIMENT 2 **3 Hours**

Select a material to be used as brake cable in a bicycle such that the material is able to withstand axial tensile loading and identify the mode of failure.

EXPERIMENT 3 **3 Hours**

Assess the suitability of material as bicycle handle to withstand bending load using deflection beam apparatus

EXPERIMENT 4 **3 Hours**

Select a material to be used as bicycle fork such that the material is able to withstand axial compressive loading and identify the mode of failure.

EXPERIMENT 5 **3 Hours**

Assess the suitability of material for fabricating LPG gas cylinders to withstand internal gas pressure using thin cylinder test setup

EXPERIMENT 6 **6 Hours**

Assess the suitability of material as nail for wooden furniture fabrication withstanding impact loading of hammer.

EXPERIMENT 7 **3 Hours**

Assess the suitability of material as a) compression spring for bicycle seat and b) tensile spring for bicycle stand to withstand

EXPERIMENT 8 **3 Hours**

Select a material to be used as bicycle wheel shaft such that the material is able to withstand torsion loading.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017
2. F. P. Beer and R. Johnston, McGraw Hill Education India Private Limited, Seventh edition, 2017
3. S. S. Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013
4. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt Ltd, New Delhi, 2015
5. William Nash and Nilanjan Malik, Strength of Materials (Schaum"s Outline Series), McGraw Hill Education, Fourth Edition, 2017
6. https://onlinecourses.nptel.ac.in/noc18_ce17/preview

22MC404 THEORY OF MACHINES 3 0 2 4

Course Objectives

- To learn various mechanisms and find their velocity and acceleration
- To perform force analysis and balancing of reciprocating engines
- To understand the function of flywheel and to determine basic parameters of flywheel
- To determine gear ratio for simple, compound, reverted and epicyclic gear train

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Find the characteristics of a given planar mechanism
2. Compare vector mechanics principles to construct velocity and acceleration diagram of planar mechanisms
3. Use reciprocating engine to find the static and dynamic forces acting on its components
4. Justify the concept of balancing of masses in rotating shafts and explain the effect of vibration
5. Compare speed and torque ratio of major gear trains

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF MECHANISMS

Basic concepts of mechanisms: link, joint, pair, chain, mechanism, machine and structure, degree of freedom, mobility of mechanism - Kutzbach criterion, Grashofs law - Inversions of mechanisms: Four bar and slider crank: Mechanical advantage, Transmission angle, Description of some common mechanisms: Straight line generators, dwell mechanisms, ratchets and escapements, universal joint-Geneva mechanism

UNIT II **9 Hours**

KINEMATICS OF MECHANISMS

Vector representation of Displacement, velocity and acceleration - Graphical method of velocity (relative velocity method) and acceleration diagrams for simple mechanisms - Coriolis component of acceleration

UNIT III **9 Hours**

KINETICS OF MECHANISMS

Static force analysis: Applied and constraint forces, Free body diagrams, Static equilibrium conditions: Two, three and four members - Static force analysis of simple mechanisms - The principle of superposition Dynamic force analysis: Inertia force and Inertia torque, D Alemberts principle, Dynamic Analysis in Four bar mechanism

UNIT IV **9 Hours**

BALANCING AND VIBRATION

Balancing:Balancing of Single Rotating mass by a single mass rotating in the same plane and two masses rotating in different planes - Several masses rotating in the same plane and different planes Vibration : Introduction - Types of vibration, Longitudinal, Transverse and torsional-free, forced and damped vibrations (basic only)

UNIT V **9 Hours**

GEARS AND GEAR TRAINS

Law of toothed gearing Involutes and cycloidal tooth profiles Spur gear terminology and definitions Gear tooth action Interference and undercutting Problems Helical, bevel, worm, rack and pinion gears, Strain wave (harmonic) gear (Basics only).

Gear trains: Introduction to gear correction, gear trains Speed ratio, train value, - Types of gear trains: Parallel axis gear trains, Epicyclic gear trains - Determination of gear speeds and torque using tabular method

6 Hours

EXPERIMENT 1

Determine moment of inertia of engine components

6 Hours

EXPERIMENT 2

Conduct dynamic analysis for a mechanism that is used in automobiles engine

6 Hours

EXPERIMENT 3

Analyse vibration in unbalanced shaft

6 Hours

EXPERIMENT 4

Find torque and speed ratio of given epicyclic gear

6 Hours

EXPERIMENT 5

Analyse the given fourbar mechanism for its kinematic behaviours

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2019
2. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2009
3. Sadhu Singh, Theory of Machines, Prentice Hall of India Learning, New Delhi, 2012
4. Kenneth J .Waldron and Garny L. Kinzel, Kinematics, Dynamics and Design of Machinery, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2007

22MC405 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Construct the 8086 architecture and write ALP for 8086 processor
2. Use hardware and software architectures of Embedded Systems
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	2	3	2	-	-	-	-	-	-	-	-	-	2	2
2	1	2	3	-	-	-	-	-	-	-	-	-	3	2
3	2	3	2	-	-	-	-	-	-	-	-	-	3	2
4	3	2	2	-	-	-	-	-	-	-	-	-	3	2
5	1	3	2	-	-	-	-	-	-	-	-	-	3	3

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

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

4 Hours

EXPERIMENT 2

Design a display system for hotel using 8086 microprocessor

5 Hours

EXPERIMENT 3

Design a ranking system for students using 8086 microprocessor

5 Hours

EXPERIMENT 4

Design a traffic light controller using TIVA-C microcontroller

6 Hours

EXPERIMENT 5

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

6 Hours

EXPERIMENT 6

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 & Programming, Dreamtech press, 2013.
3. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, 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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Examine the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Identify the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts 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	-	-	-	-	-	-	2
4	1	-	-	-	-	-	-	-	-	-	-	-	-	2
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 and appreciate the nuances of the language and engage an audience
- Use advanced tools of language to improve communicative competence and prepare for professional demands at the workplace

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. Understand the clarity in articulating the objectives and aims and improved proficiency in usingthe English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage theaudience, 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 techniqueswith 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 – 1 - CREATIVE EXPRESSION 15 Hours

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 2 - FORMAL EXPRESSION **15 Hours**

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. 1990, Delhi
6. English Grammar, Composition and Usage by N.K.Agrawal&F.T.Wood, Macmillan India Ltd., New Delhi

22HS010 **SOCIALLY RELEVANT PROJECT** **L T P C - - 0 0 2 -**

Course Objectives

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

Programme Outcomes (POs)

PO1 Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 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 public health and safety, and the cultural, societal, and environmental considerations.

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

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

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.

Course Outcomes (COs)

The students will be able to

CO1 Interact with society conduct a field surveys and identify societal issues.

CO2 Analyze societal problems using engineering principles.

CO3 Develop plan and provide optimal solutions for social issues using their engineering knowledge and skills.

CO4 Prepare comprehensive reports on their findings and proposed solutions. **CO5** Enhance the social responsibility and ethical considerations in engineering.

CO6 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	3	-	2	-	-
3	2	-	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

22MC501 ROBOTICS AND MACHINE VISION 2 1 2 4

Course Objectives

- To acquire knowledge on the fundamentals of robotics and machine vision systems
- To develop the kinematic model of an industrial manipulator
- To understand the concept of robot work cell design and the applications of the robotic systems.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select the robot systems and robotic manipulators based on their mobility and interpret the fundamental terminologies used in robotic
2. Demonstrate gripper mechanisms and select suitable gripper for a robotic application
3. Compute the kinematic model of the robotic systems using the fundamental transformation and homogeneous transformation matrices
4. Use an appropriate robot work cell layout for different applications in manufacturing and assembly sectors

5. Design path planning techniques for navigation and outline the applications of mobile robots and machine vision systems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ROBOTICS

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robots-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links- Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system

UNIT II **8 Hours**

END EFFECTORS AND ROBOT CONTROLS

Mechanical grippers Slider crank mechanism Screw type Rotary actuators, cam type Magnetic grippers-Vacuum grippers Air operated grippers-Gripper force analysis-Gripper design-Simple problems- Robot controls-Point to point control, Continuous path control, intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control

UNIT III **10 Hours**

ROBOT KINEMATICS

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Denavit- Hartenberg convention, forward and inverse kinematics solution for SCARA configured robot

UNIT IV **9 Hours**

ROBOT CELL DESIGN AND APPLICATIONS

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using software. Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and underwater robot

UNIT V **9 Hours**

MOBILE ROBOTICS AND MACHINE VISION

Introduction - types of mobile robot - kinematics of wheeled mobile robot -Path planning techniques in field robots- Machine Vision Systems- CCD/CMOS camera-Imaging techniques Non-conventional industrial robots- Mobile Manipulators- ROS and programming.

3 Hours

EXPERIMENT 1

Visualization of Denavit- Hartenberg parameters

3 Hours

EXPERIMENT 2
Simulation of forward kinematics of 3R robot

3 Hours

EXPERIMENT 3
Simulation of forward kinematics of 3P robot 4

3 Hours

EXPERIMENT 4
Simulation of Forward kinematics of PRP configured robot

3 Hours

EXPERIMENT 5
Simulation of Forward and inverse kinematics of SCARA robot.

3 Hours

EXPERIMENT 6
Generate a program in CpROG environment for pick and place operation

3 Hours

EXPERIMENT 7
Generate a program for forward kinematics numerical solution for 3 degrees of freedom robot manipulator

3 Hours

EXPERIMENT 8
Generate a program for forward kinematics numerical solution for 5 degrees of freedom robot manipulator

3 Hours

EXPERIMENT 9
Develop a continuous motion program using 6 axis industrial robot for spray painting

3 Hours

EXPERIMENT 10
Develop a point to point motion program using 6 axis industrial robot for pick and place operation

Total: 90 Hours

Reference(s)

1. Mikell P Groover & Nicholas G Odrey, Mitchell Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, 2nd Edition, Tata McGraw- Hill Education, 2017.
2. S.K. Saha, Introduction to Robotics, 2nd Edition, Tata McGraw-Hill Education, 2014
3. S.R. Deb, Robotics Technology and flexible automation, 2nd Edition, Tata McGraw-Hill Education, 2017
4. Roland Siegwart, Nourbaksh I. R., Scaramuzza D., 2nd Edition, The MIT press, 2011
5. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, PHI Learning, 2009.
6. NPTEL - https://nptel.ac.in/courses/112105249/

22MC502 MANUFACTURING TECHNOLOGY 3 0 2 4

Course Objectives

- To understand the fundamentals of casting processes, sand moulding, plastic moulding, and their technique.
- To explore various metal joining processes, including welding, brazing, soldering, and adhesive bonding methods.
- To study metal forming processes like forging, rolling, extrusion, and sheet metal work.
- To explore the constructional features and working principles of machine tools, cutting tools, cutting fluids, and the basics of CNC machines.
- To examine non-conventional machining methods like EDM, ECM, and 3D printing.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate casting and molding techniques to manufacture components based on material properties and production requirements in industrial applications.
2. Apply the principles of welding, brazing, soldering, and adhesive bonding for assembling components in automotive, aerospace, and manufacturing applications.
3. Choose the suitable metal forming processes, such as forging, rolling, extrusion, or drawing, to manufacture components in a sheet metal industry.

4. Identify the appropriate machine tool for specific machining operations to achieve desired precision and efficiency in manufacturing processes.
5. Examine the appropriate non-conventional machining method to process complex shapes or hard-to-machine materials in advanced manufacturing applications.

Articulation Matrix

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

UNIT I **6 Hours**

CASTING PROCESSES

Introduction to Foundry - Procedure to make sand mould, types of cores, moulding tools, machine moulding - pattern, sand testing, - casting defects and remedies. Introduction to Plastics - Moulding of Thermoplastics - Injection moulding -Plunger and screw machines -Blow moulding -Rotational moulding - Flim blowing - Thermoforming - Compression moulding -Transfer moulding

UNIT II **6 Hours**

JOINING PROCESSES

Types of Metal Joining Process - Introduction to welding process - Principle of arc and gas welding - Tools and equipment - Filler and flux materials - Flame types - Weld defects - Safety in welding - Special welding processes: resistance welding, Friction welding, TIG welding, MIG welding - Brazing and soldering - Adhesive bonding

UNIT III **6 Hours**

METAL FORMING THEORY

Introduction to hot and cold working - Forging: open and close die, upsetting - Rolling: high roll mills and shape rolling - Extrusion: forward and backward, tube extrusion - Drawing of wires, rods and tubes - Sheet metal work: Shearing, bending and drawing operations - Powder metallurgy (basics only)

UNIT IV **6 Hours**

MACHINE TOOLS

Cutting tools & materials, cutting fluids, metal cutting theory, Merchants circle, constructional features of machine tools: Universal milling machine, shaping machine, cylindrical grinding machine, capstan and turret lathe - Basics of CNC machines

UNIT V **6 Hours**

NON CONVENTIONAL MACHINING

General principles and applications - Water jet machining (WJM), Abrasive Jet Machining (AJM) Electro Discharge Machining (EDM), Electro Chemical Machining (ECM) and Laser Beam Machining (LBM), Ultrasonic Machining (USM)FOR FURTHER READING 3D Printing - Technologies, Processes, STL File, Advantages and Disadvantages; Laser Beam Welding; Automated Molding system

3 Hours

EXPERIMENT 1

Machining a cotter pin whose diameter is continuously varying throughout its length

3 Hours

EXPERIMENT 2

Making a model of screw used in vernier caliper

3 Hours

EXPERIMENT 3

Practicing to make models like table, chair, rack, teapoy, stool, etc using arc welding equipment

3 Hours

EXPERIMENT 4

Fabrication of a pin and hole with push fit assembly using centre lathe

3 Hours

EXPERIMENT 5

Preparing the shaft/key/coupling assembly by selecting suitable machining operations and to list the sequence of operations.

3 Hours

EXPERIMENT 6

Machining of flange with four holes placed and with internal thread at the centre to connect pipes

3 Hours

EXPERIMENT 7

Machining a spur gear with n number of teeth with 2 mm module by selecting suitable machine tool.

3 Hours

EXPERIMENT 8

Grinding of single point cutting tool in the 10 mm MS square rod with standard nomenclature using tool and cutter grinding machine

3 Hours

EXPERIMENT 9

Preparing the surface of the shaft within the tolerance limit of Ã‚Â±0.002 mm to assemble with a bearing of inside diameter
22 mm

3 Hours

EXPERIMENT 10

Producing a square bar from the given shaft with minimum material wastage by selecting suitable machining operations

Total: 60 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2014
2. P. N. Rao, Manufacturing Technology - Vol I and II, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2013.
3. D. K. Singh, Fundamentals of Manufacturing Engineering, ANE Books, New Delhi, 2008
4. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall of India Learning. Ltd., New Delhi, 2009
5. T. R. Mishra, Non-Conventional Machining, Narosha Publishing House, New Delhi, 2012
6. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Pearson Education, New Delhi, 2015.

22MC503 THERMODYNAMICS AND HEAT TRANSFER 3 0 2 4

Course Objectives

- To enlighten the knowledge of students about the fundamentals of thermodynamics and heat transfer

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Use fundamental thermodynamic properties and laws for engineering problems
2. Demonstrate various thermodynamic process and solve steady flow energy equation for engineering system
3. Select the concept of entropy and evaluate efficiency for major thermodynamic gas power cycles
4. Compare fundamentals of heat transfer and overall heat transfer coefficient of a system
5. Outline the convection and radiation heat transfer coefficient for an engineering system

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

UNIT I **9 Hours**

INTRODUCTION TO THERMODYNAMICS

Thermodynamic systems. Temperature and the zeroth law of thermodynamics. Thermodynamic scales. Ideal gas. Simple, compressible pure substances: gases and steam .Numerical problems

UNIT II **9 Hours**

FIRST LAW OF THERMODYNAMICS

Expansion work. Friction work. Internal energy. Heat. Enthalpy. Specific heats of gasses. Adiabatic, isothermal, isochoric and isobaric processes. Polytropic processes. First law of thermodynamics. Open and closed systems, steady flow energy equation- Numerical problems

UNIT III **9 Hours**

SECOND LAW OF THERMODYNAMICS

Entropy and irreversibilities. Second law of thermodynamics. Thermal engine. Carnot"s efficiency. Isentropic processes and isentropic efficiencies for thermal engines. Gas turbine: Brayton cycle. Steam turbine: Rankine cycle. Steam compression refrigeration systems. Numerical problems.

UNIT IV **9 Hours**

CONDUCTION

General differential equation for conduction heat transfer. Conduction in a flat wall. Conduction in a cylindrical wall. Thermal resistance. Overall heat transfer coefficient. Numerical problems

UNIT V **9 Hours**

CONVECTION AND RADIATION

Free and forced convection mechanism. Interior and exterior convection. Convection over flat surfaces. Convection over cylinders. Electromagnetic spectrum and radiation physics. Kirchoffs law. Black-body radiation. Numerical problems

3 Hours

EXPERIMENT 1

Experimental study on port timing and valve timing diagram of IC engines.

3 Hours

EXPERIMENT 2

Experimental study on performance test of 4-Stroke diesel engine

3 Hours

EXPERIMENT 3

Experimental study on heat balance test of 4-Stroke diesel engine

3 Hours

EXPERIMENT 4

Experimental study on performance test of 4-Stroke Petrol engine

3 Hours

EXPERIMENT 5

Experimental study on determination of Coefficient of Performance of refrigeration system

3 Hours

EXPERIMENT 6

Experimental study on determination of Coefficient of Performance of Air-conditioning system

3 Hours

EXPERIMENT 7

Determination of thermal conductivity for one dimensional steady state conduction

3 Hours

EXPERIMENT 8

Determination of heat transfer co-efficient by unsteady heat transfer

3 Hours

EXPERIMENT 9

Determination of heat transfer co-efficient by natural convection

3 Hours

EXPERIMENT 10

Determination of Stefan-Boltzmann constant

Total: 75 Hours

Reference(s)

1. 1. P. K. Nag, Engineering Thermodynamics, Edition 6, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI Units, Tata McGraw Hill Publishing Company, New Delhi, 2017
3. R. K. Rajput, Thermal Engineering, Laxmi Publications, 2020.
4. C. P. Kothandaraman and S. Subramanya, Fundamentals of Heat and Mass Transfer, New Age International Publishers, New Delhi, 2012
5. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, Pearson, New Delhi, 2004
6. NPTEL - https://nptel.ac.in/courses/112105123/1

22MC504 CONTROL SYSTEMS ENGINEERING 3 1 0 4

Course Objectives

- To describe feedback control and basic components of control systems
- To understand the various time domain and frequency domain tools for analysis and design of linear control systems
- To study the methods to analyze the stability of systems from transfer function forms
- To describe the methods of designing compensators

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Demonstrate a mathematical model of a physical system and compute the transfer function using block diagram reduction technique and Signal flow grap
2. Assess the performance of first and second order system and compute the steady state error for different test signals
3. Find the frequency domain response and determine the phase margin and gain margin using bode plot, polar plot and Nyquist plot
4. Use the cascade compensation and design a lag, lead and lag-lead series compensator using bode plot
5. Outline the system controllability and observability using state space approach

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

UNIT I **9 Hours**

SYSTEMS REPRESENTATION

Basic elements in control systems - open loop and closed loop with applications - Transfer functions of mechanical, electrical and analogous systems - Block diagram reduction signal flow graphs

UNIT II **10 Hours**

TIME RESPONSE ANALYSIS

Time response - Time domain specifications -Types of test inputs I and II order system response - Steady state error, error constants - Stability concept and definition Characteristic equation - Location of poles - Routh Hurwitz criterion - Root locus techniques: construction

UNIT III **9 Hours**

FREQUENCY RESPONSE ANALYSIS

Bode plots - Polar plot - Nyquist stability criterion - Correlation between frequency domain and time domain specifications - stability analysis using frequency response methods.

UNIT IV **9 Hours**

COMPENSATOR AND CONTROLLER DESIGN

Realization of basic compensators - cascade compensation in time domain and frequency domain - feedback compensation - Design of lag, lead, lag-lead series compensator (using Bode plot)- Introduction to P, PI, PID controllers

UNIT V **8 Hours**

STATE SPACE ANALYSIS

State equation - Solutions, Realization, Controllability, Observability - State space to transfer function conversion.

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

22MC507 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.

Program Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

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	PSO3
1	-	3	2	-	-	2	1	-	-	-	-	-	2	3	-
2	2	2	1	3	-	2	-	-	-	-	2	2	2	3	2
3	-	-	3	2	2	-	-	2	-	-	2	2	2	3	-
4	-	1	-	2	3	1	2	2	-	-	-	-	2	3	-
5	-	-	-	-	-	-	-	-	3	3	-	2	2	3	-

22MC601 INDUSTRIAL AUTOMATION AND IOT 3 0 2 4

Course Objectives

- To understand the need of automation in various industrial sectors
- To learn about the various technology developments such as PLC, SCADA and DCS in industrial automation
- To understand the basics of communication with its protocol

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate automation techniques and levels of automation for industrial applications.
2. Design PLC systems using architecture, programming, ladder logic, and advanced instructions to meet industrial needs.
3. Apply supervisory control and data acquisition (SCADA) systems for industrial applications to enable real-time monitoring, and efficient management of industrial processes.
4. Apply the concept of distributed control systems (DCS) in industrial automation for real-time monitoring, and efficient control of complex industrial processes.
5. Choose and implement suitable communication buses and protocols in industrial applications to achieve reliable data transmission, and efficient process management.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF AUTOMATION AND IOT

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms. Internet of Things (IoT): Architecture – IoT Standards – Case studies.

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming Languages-Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT III **9 Hours**

COMMUNICATION PROTOCOLS

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses -Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

UNIT IV **9 Hours**

SUPERVISORY CONTROL AND DATA ACQUISITION

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode functions-Tools: Tag database-Recipe database- Alarm Logging-Trends: Real Time, Historical TrendsSecurity and User Access Management-Management Information System-Report Function

UNIT V **9 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

6 Hours

EXPERIMENT 1

Design a control panel with SMPS and interface Input /output devices such as HMI, Relay, with programmable logic controller (PLC) according to industrial standard.

6 Hours

EXPERIMENT 2

Develop a PLC program to interface minimum 8 DI/DO and 2 AI/AO to a factory or process automation plant using ladder logic or SFC or Functional Block.

6 Hours

EXPERIMENT 3

Visualization of Diverse Sensors data, PLC I/O status and Variable Frequency Drives using Dashboard.

6 Hours

EXPERIMENT 4

Design a SCADA screen to display the plant information such as temperature, pressure and humidity using historical trends

6 Hours

EXPERIMENT 5

Design a SCADA screen for automatic level monitoring system

Total: 75 Hours

Reference(s)

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2002
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009
5. Lucas M.P, Distributed control systems, Van Nostrand Reinhold Company, Newyork, 1986

22MC602 POWER ELECTRONICS AND DRIVES 3 0 2 4

Course Objectives

- To obtain the switching characteristics of different types of power semi-conductor devices
- To determine the operation, characteristics and performance parameters of converters
- To understand the concept of DC and AC drives

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the switching characteristic of different types of power semi-conductor devices
2. Assess the operation, characteristics and performance parameters of converters
3. Show various inverter techniques and harmonics elimination methods
4. Find the speed control of solid state DC drives
5. Outline the speed control methods of AC machines and power factor correction

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

UNIT I **8 Hours**

POWER SEMICONDUCTOR DEVICES

Construction, Operation, Characteristics of Power Diode SCR TRIAC - Power transistor MOSFET and IGBT - di/dt and dv/dt protection, introduction to driver and snuber circuits.

UNIT II **10 Hours**

CONVERTERS AND CHOPPERS

Phase Control Single Phase and Three phase uncontrolled and controlled rectifiers with R and RL load, performance parameters, Choppers, Time ratio control, Types, Buck-boost chopper-four quadrant operation cycloconverters Aplications-Batery operated vehicles.

UNIT III **7 Hours**

INVERTERS

Single phase and three phase voltage source inverters PWM techniques Sinusoidal PWM modified sinusoidal PWM and multiple PWM Current source inverters Harmonics elimination technique Applications Induction heating, UPS.

UNIT IV **10 Hours**

SOLID STATE DC DRIVES

Types of electrical drives - selection of drives - heating and cooling curves - Four quadrant operation of hoist - Ward Leonard control system - Control of DC drives using rectifiers and choppers.

UNIT V **10 Hours**

SOLID STATE AC DRIVES

Control of three phase induction motors using stator voltage and frequency control - variable frequency drive - static rotor resistance control - Slip power recovery schemes - Static Kramer control method - Static Scherbius control method - Power factor correction. vector control- Aplications.

6 Hours

EXPERIMENT 1

Create a new simulation model for the rectifier, inverter to verify the efficiency

6 Hours

EXPERIMENT 2

Create a new simulation model of chopper and cycloconverter to verify the efficiency

6 Hours

EXPERIMENT 3

Construct closed loop Class A chopper drive circuit and to control the speed of the dc motor.

6 Hours

EXPERIMENT 4

Control the speed of the DC motor with direct torque control using digital simulation

6 Hours

EXPERIMENT 5

Control the speed of the Induction motor with direct torque control using digital simulation

Total: 75 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2017.
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007.
3. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd., New Delhi, 2012.
4. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2017. 5
5. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2013.
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2018.

22MC603 FLUID POWER SYSTEM 2 1 2 4

Course Objectives

- To gain knowledge on properties of fluid and various types of losses in fluid
- To understand the construction and working principle of various components used in hydraulic and pneumatic systems
- To design hydraulic and pneumatic circuits for various applications using software and hardware tools

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Apply the concept of fluid power system to determine head losses and pump power.
2. Select suitable hydraulic pumps and suitable actuators used in hydraulic system
3. Determine the hydraulic valvess for the fluid power application.
4. Choose the components to design a pneumatic system
5. Design the hydraulic and pneumatic circuits for a given application using various methods.

Articulation Matrix

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

UNIT I **6 Hours**

FLUID POWER SYSTEMS

Introduction to fluid power History Pascals law Comparison between various type of energy medium - Advantages - Drawbacks Applications of fluid power system in various sectors. Hydraulic fluids Properties and functions. Filtration system Darcys equation Frictional losses. Losses in valves and fittings Determination of head losses & pump power in a hydraulic circuit Numerical Problems.

UNIT II **6 Hours**

HYDRAULIC PUMPS AND ACTUATORS

Positive and non-positive displacement pumps Pumping theory and classification Construction and working principle of Gear Vane and Piston pumps Variable Displacement Pumps Pump performance curves Hydraulic cylinders Construction Working principle Single acting Double acting Double rod cylinder and Telescopic cylinder. Hydraulic motors Gear Vane and Piston motors Numerical Problems.

UNIT III **6 Hours**

HYDRAULIC VALVES

Directional Control Valves Check valve Pilot operated check valve methods of valve actuation working principle of 2/2 3/2, 4/2 ,4/3 and 5/2 DCV - Shuttle valve. Pressure control Valves: Pressure relief valves - Pressure reducing valve - Unloading valves - Counterbalance valves - Flow control valves - Proportional and Servo valves: Mechanical type.

UNIT IV **6 Hours**

PNEUMATICS SYSTEM

Introduction - Properties of air - gas laws - Compressors: Piston compressor, Screw compressor and Vane compressor. Fluid conditioners: Air filters, Air pressure regulators, Air lubricators, Pneumatic silencers, After coolers and Air dryers. Pneumatic actuators: Pneumatic cylinders, Rotary air motors and Performance curves

UNIT V **6 Hours**

DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS

Fluid power Symbols - Basic circuit - Meter in and Meter Out Circuit - Counter balance Circuit - Pipe Sizing Calculations. Sequential circuit design for simple applications: Step counter method, Cascade methods & Karnaugh Veitch map method

EXPERIMENT 1 **3 Hours**
Identification of fluid power system components and their symbols.

EXPERIMENT 2 **3 Hours**
Actuation of a single and double acting cylinder using limit switch and push button in the simulation software.

EXPERIMENT 3 **3 Hours**
Developing an Actuation of meter in, meter out circuit and simulating using the simulation software.

EXPERIMENT 4 **3 Hours**
Simulation of fluid power circuits with logic controls (AND valve and OR valve).

EXPERIMENT 5 **3 Hours**
Developing and Simulating Synchronizing and quick exhaust circuit.

EXPERIMENT 6 **3 Hours**
Design of fluid power circuit for sorting operation/packing operation using Karnaugh Veitch method and simulate the operation in a simulation software.

EXPERIMENT 7 **3 Hours**
Design of pneumatic circuit for a drilling operation and simulate the operation in a simulation software (use step counter method).

EXPERIMENT 8 **3 Hours**
Design of hydraulic circuit for a pick and place operation using cascade method and simulate the operation

EXPERIMENT 9 **3 Hours**
Developing and Sequencing of three double acting cylinder (A+A-B+B-) twice and C+C- once using relay counter.

Total: 72 Hours

Reference(s)

1. Anthony Esposito, Fluid Power with Applications, Pearson Education New Delhi, 2015
2. S. R. Majumdar, Oil Hydraulics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2015
3. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2016
4. S. R. Majumdar, Pneumatic systems - Principles and maintenance, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2014.
5. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2015
6. https://nptel.ac.in/courses/112105047

22MC607 MINI PROJECT II **0 0 2 1**

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.

Program Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. 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.
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. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

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, 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 a report and present the oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	3	1	3	3	3	3	3	-	2	3	3	3
2	2	2	3	3	1	3	3	3	3	3	-	2	3	3	3
3	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3
4	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3
5	2	2	-	-	2	-	-	3	3	3	-	2	3	3	3

22MC701 DESIGN OF MECHATRONICS SYSTEM 3 0 2 4

Course Objectives

- To study about mechatronics design process
- To study the Electro pneumatics in Mechatronics system
- To Understand about the application of mechatronics system

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Apply the mechatronics design process to data acquisition and control through case studies
2. Compare the various System modelling parameters available in mechatronics system
3. Analyse the aspects of real time interfacing in mechatronics system design
4. Justify the different design technology for various applications
5. Design micro mechatronics system and implementing in real time systems

Articulation Matrix

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

UNIT I **9 Hours**

ELEMENTS OF MECHATRONICS SYSTEM

Key elements Mechatronics Design process Design Parameters Traditional and Mechatronics designs - Advanced approaches in Mechatronics - Industrial design and ergonomics, safety

UNIT II **9 Hours**

ELECTRO PNEUMATICS

Components and symbols of electro pneumatics Electrical Logical connection relay circuit Latching unlatching Solenoid operated valve Direct and indirect electrical actuation of Solenoid valve Memory circuit with solenoid valve open loop and closed loop control Proximity sensor Timer and counter Application pneumatic speed control multi cylinder control Diverting packages, sealing plastic can Palletising

UNIT III **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process, Application Software Lab view Environment and its applications, Vim-Sim Environment & its applications Man machine interface

UNIT IV **9 Hours**

PROGRAMMING PLC

Ladder logic I/O addressing, registers basics, basic relay instructions, timer-counter instructions, arithmetic functions, comparison functions, data handling, data move functions, input-output instructions, sequencer instructions, Functional block, Sequential Flow control Programming Application PLC control of pneumatic cylinder and multi cylinder control.

UNIT V **9 Hours**

MODULAR PRODUCTION SYSTEM

Introduction Components/ commissioning of Modular production system (MPS) Commissioning, Assembly interfacing and programming of Distribution station, Pick and place station, Handling station and Measuring station.

6 Hours

EXPERIMENT 1

Design a control panel with SMPS and interface Input output devices such as HMI, Relay, with programmable logic controller (PLC) according to industrial standard.

6 Hours

EXPERIMENT 2

Design / Develop a PLC program to interface minimum 8 DI/DO to a factory or process automation plant using ladder logic

6 Hours

EXPERIMENT 3

Design / Develop a PLC program to interface minimum 2 AI/AO to a factory or process automation plant using SFC/Functional Block

6 Hours

EXPERIMENT 4

Demonstrate / Interface the control of Factory automation plant with minimum 4DI/DO using Programmable logic controller.

6 Hours

EXPERIMENT 5

Demonstrate / Interface the control of process automation plant with minimum 4DI/DO using Programmable logic controller.

Total: 75 Hours

Reference(s)

1. Bishop, Robert H, Mechatronics Hand book,CRC Press, 2002.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, CRC Press 1991 , First Indian print 2010.
3. De Silva, Mechatronics: A Foundation Course, Taylor & Francis, Indian Reprint, 2013.
4. Devdas shetty, Richard A. Kolk, Mechatronics System Design, 2nd Edition ,Cengage Learning 2011
5. Georg pelz, Mechatronic Systems: Modeling and simulation with HDL"s, John wiley and sons Ltd, 2003

22MC702 MACHINE LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the fundamentals of supervised learning algorithms
- To acquire knowledge on unsupervised learning algorithms
- To gain the knowledge on reinforcement algorithm
- To develop the neural networks and convolutional neural networks for object classifications.
- To perform object detection using CNN, RCNN, SSD and Yolo.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Explain the basic concepts of supervised learning and types of regression models.
2. Describe the characteristics and techniques of unsupervised learning.
3. Apply clustering and dimensionality reduction techniques to real-world data.
4. Analyze the effectiveness of RL algorithms for dynamic environments.
5. Assess the effect of hyperparameters and network depth on classification accuracy.

Articulation Matrix

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

UNIT I **9 Hours**

SUPERVISED LEARNING METHODS

Introduction to learning & classifiers, classification and regression. bayes linear regression logistic regression support vector mechanism Random forest Non Linear Regression Polynomial Regression.

UNIT II **9 Hours**

UNSUPERVISED LEARNING METHODS

Clustering and association K means clustering K nearest neighbor Hierarchical clustering probabilistic clustering Autoencoders Apriori algorithm Principle component analysis independent component analysis Singular value decomposition.

UNIT III **9 Hours**

REINFORCEMENT LEARNING METHODS

Terms in Reinforcement Learning Key features and Elements Bellman Equation Types of Reinforcement Learning Reinforcement Learning Algorithm Markov Decision Process Monte Carlo Methods QLearning Applications of Reinforcement Learning.

UNIT IV **9 Hours**

DEEP LEARNING

Introduction Image Fundamentals Layers Neuron Hyperparameter activation functions learning rate forward and back propagation gradient descent Neural network CNN Image classification.

UNIT V **9 Hours**

OBJECT DETECTION METHODS

ImageNet VGG Net ResNet MobileNet R-CNN Faster R-CNN Single shot detector(SSD) You only look once (YOLO) Face recognition gesture recognition object recognition.

Total: 45 Hours

Reference(s)

1. Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, London, 2014.
2. Vaibhav Verdhan, Computer Vision Using Deep Learning: Neural Network Architectures with Python and Keras, 1st ed. Edition, Apress, 2021.
3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Second edition, The MIT Press, 2015.
4. S. Rajasekaran, GA Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, Prentice Hall of India Private Limited, 2003.
5. Simon Haykin, Neural Networks, A comprehensive foundation, Prentice Hall, 3rd Edition, 2004.
6. https://onlinecourses.nptel.ac.in/noc18_cs26/course.

22MC707 PROJECT WORK I 0 0 4 2

Course Objectives

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

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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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.
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PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select a real world problem and develop the design solutions.
2. Comparetechnical ideas, strategies and methodologies
3. Integratethe newtools, algorithms, techniques that contribute to obtain thesolution of theproject
4. Check and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Generate report and present oral demonstrations

Articulation Matrix

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

22MC801 PROJECT WORK II 0 0 20 10

Course Objectives

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

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select a real world problem and develop the design solutions.
2. Comparetechnical ideas, strategies and methodologies
3. Integrate the new tools, algorithms, techniques that contribute to obtain the solution of theproject
4. Check and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Generate report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	3	2	-	-	2	1	-	-	-	-	-	2	3	-
2	2	2	1	3	-	2	-	-	-	-	2	2	2	3	2
3	-	-	3	2	2	-	-	2	-	-	2	2	2	3	-
4	-	1	-	2	3	1	2	2	-	-	-	-	2	3	-
5	-	-	-	-	-	-	-	-	3	3	-	2	2	3	-

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 to comprehend complex content
- Enhance confidence in expressing with clarity and elegance with enthusiastic and reflective use of the language

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Understand 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-EXPRESSION

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 anno uncements 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 FoundationBooks, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book forIntermediate 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 Supervisionand 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 -daysituations
- To teach them how to converse in Hindi on simple day- to -daysituations

Programme Outcomes (POs)

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.

Course Outcomes (COs)

- Construct simple sentences and use vocabulary required for day- to -day conversation
- Distinguish and understand the basic sounds of Hindi language
- Appear for Hindi examinations conducted by Dakshina Bharat Hindi Prachar Sabha

Articulation Matrix

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

UNIT I **9 Hours**

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

UNIT II **9Hours**

Nouns: Genders (Masculine & Feminine Nouns)- Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

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

UNIT V **9 Hours**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions

Total: 45 Hours

Reference(s)

1. Hindi Prachar Vahini-1 by Dakshin Bharat Hindi Prachar Sabha Chennai
2. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People,Vee Kumar Publications(P)Ltd., New Delhi,2009

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)

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.

Course Outcomes (COs)

- listen and identify individual sounds of German
- use basic sounds and words while speaking
- read and understand short passages on familiar topics
- use basic sentence structures while writing
- understand 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	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	3	-	-	-	-

UNIT I **9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

UNIT II **9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

UNIT III **9 Hours**

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

UNIT IV **9 Hours**

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

UNIT V **9 Hours**

Verbs - to be & to have - conjugation - Hobbys - 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 etiquettes

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. Recognise and write Japanesealphabet
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	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
3	-	-	-	-	-	-	-	-	-	2	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	2	-	-	-	-

UNIT I **9 Hours**

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. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka N1 mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano N - Sou desu - Sou ja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira Achira - N1 wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do (Demonstrative words) - O kuni Kanji10 - Technical Japanese Vocabulary (30 Numbers)

UNIT II **9 Hours**

Introduction to time - Ji - Fun - Pun - Introduction of verbs - V Masu - V Masen - V Mashita - V Masendeshita N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu – Kimasu Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vechile) de Ikimasu - Kimasu - Kaerimasu - N (Person / Animal) to V - Itsu - S Yo N o (transitive) - N o Shimasu - Nani o Shimasuka Nan and Nani N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical JapaneseVocabulary (30 Numbers) .

UNIT III **9 Hours**

N (tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives - N wa Na adj (Na) desu - N wa II adj (II) desu - Na adj Na n - II adj (II) N - Totemo - Amari - N wa Dou desuka - N1 wa Donna N2 desuka - S1 Ga S2 - Dore N ga Arimasu - Wakarimasu - N Ga Sukidesu - Kiraidesu - Jozu desu - Heta desu - Donna N - Yoku - Daitai - Takusan - Sukoshi - Amari - Zenzen - S1 kara S2 - Doushite - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT IV **9Hours**

N ga Arimasu - Imasu - N1 (place) Ni N2 ga Arimasu - Imasu - N1 (thing/person/place) no N2 (position) - N1 ya N2 - Word (s) desuka - Chirisosu wa Arimasuka - Saying numbers - Quantifier (period) Ni kai V - Quantifier Dake - N dake - Past tense of Noun sentences and Na adjective sentences - Past tense of ii adjective sentences - N1 wa N2 yori adjective desu - N1 to N2 to dochira ga adjective desu ka - N1/N2 no houga adjective desu - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT V **9Hours**

N ga hoshi desu - V masu formtai desu - N (place) e V masu form- N Ni - ikimasu - kimasu - kaerimasu N ni V - N o V - dou ko ka - nani ka - go chuu mon - Verb conjugation - Verb groups - Verb te form - V te form kudasai - V te form imasu - V masu from mashouka - S1 ga S2 - N ga V - V te form mo ii desu - V te form wa ikemasen - V te form imasu Shrimasen - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

Total: 45 Hours

Reference(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

22HSC01 CHINESE 1 0 2 2

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

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

UNIT I **9 Hours**

Hello

Initials and Finals of Chinese b,p,m,f,d,,n,l,g,k,h,j,q,x Tones

Four 3.Chinese Syllables4.Tone S

UNIT II **9 Hours**

Thank you - Initials and Finals of Chinese - The Neutral Tone - Rules of Tone Marking and Abbreviation

UNIT III **9 Hours**

What"s your name - In the school; -In the classroom; -In the school - The Interrogative Pronoun 2 The Sentence3 Interrogative Sentences with

UNIT IV **9 Hours**

She is my Chinese teacher - In the library The
Interrogative Pronouns
The Structural Particle The
interrogative Particle

UNIT V **9 Hours**

Her daughter is 20 years old this year -
1.The Interrogative Pronoun
1. Numbers below 100
3.Indicating a Change The
Interrogative Phrase

Total: 45 Hours

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-dayscenarios

Programme Outcomes (POs)

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.

Course Outcomes (COs)

1. To 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 understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

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

UNIT I 9 Hours

ENTRER EN CONTACT

La langue francaise, alphabets, les numeros, 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 - Les alphabets, 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, d'ecrire son voisin, s'informer sur un logement Lexique L'habitat, les pieces, l'equipement, la description physique

UNIT III 9 Hours

VIVRE AU QUOTIDIEN

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, future proche Communication- Exprimer ses gouts, parler deses loisirs, justifier unchoix, 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 - OUVRIR -*Ãƒ?Ã,Â* LA CULTURE

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait | Communication - Propose quelqu un de faire quelque chose, raconteur une sortie au passe parler unfilm |Lexique - Les sorties, la famille, 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 refuse rune invitation, donner des instructions, commander au restaurant | Lexique Les services et les commerces, les aliments, les ustensiles, argent

Reference(s)

1. Saison A1, Methode de francais
2. Hachette FLE

22MC001 MODELLING OF INDUSTRIAL ROBOTS 3 0 0 3

Course Objectives

- To understand the concepts of robot work-cell and types of end-effectors
- To construct the kinematic, dynamic and trajectory motion model of a robotic manipulator.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Compare the characteristics of serial and parallel manipulators and select appropriate robot, workcell and accessories for a desired application.
2. Apply forward and inverse kinematics and DH convention for estimating the position and orientation of serial manipulator.
3. Analyze velocity propagation and static force transformations in robotic manipulators using Jacobians, singularity analysis, and workspace considerations.
4. Develop dynamic models of robotic systems using Lagrangian and Newton-Euler approaches.
5. Design and analyze trajectory planning techniques like polynomial and trigonometric trajectories, to optimize robot motion profiles.

Articulation Matrix

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

UNIT I **8 Hours**

ROBOTS AND END EFFECTORS

Robotics: A brief history, laws of Robotics Differentiate serial and parallel manipulator - concept of workcell selection of robot specification - classification of Industrial robot manipulator based on configuration end effector mechanism and types.

UNIT II **9 Hours**

KINEMATICS OF ROBOT MANIPULATOR

Representing position and rotation - Dot and Cross product - coordinate frames - rotation in plane rotation in three dimension - Rotational transformation - Translational transformation - Euler angle, Roll Pitch, Yaw angles Axis/angle representation - rigid motion - Homogeneous transformation - Denavit Hartenberg convention - inverse and forward kinematics and problems

UNIT III **10 Hours**

VELOCITY ANALYSIS AND STATIC FORCE ANALYSIS

Representation of Linear and Angular Velocity of Manipulator Links Skew Symmetric matrix representation Velocity Forward Propagation Velocity Manipulator Jacobian. Static Force Analysis: Force transformation of robotic manipulators Force Jacobian Singularity Analysis, Workspace Singularities.

UNIT IV **9 Hours**

ROBOT DYNAMICS

Introduction, Lagrangian mechanics, Effects of moments of Inertia, Euler- Lagrangian Dynamic Modelling,
Newton-Euler Dynamic Modelling- Dynamic equation for two axis planar articulated robot.

UNIT V **9 Hours**

TRAJECTORY PLANNING

Overview on Trajectory Planning, One and multi-dimensional trajectory, basic motion profiles, analytic expressions of elementary trajectories- polynomial trajectory- cubic and fifth order polynomial trajectory Trigonometric trajectory, Parameters influencing the optimal trajectory planning of robots.

Total: 45 Hours

Reference(s)

1. Mikell P Groover & Nicholas G Odrey, Mitchell Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, 2nd Edition, Tata McGraw- Hill Education, 2017
2. S.K. Saha, Introduction to Robotics, 2nd Edition, Tata McGraw-Hill Education, 2014
3. J.J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Edition, Prentice Hall Inc. / Pearson Education, 2014
4. Mark W Spong, Seth Hutchinson, M.Vidyasagar Robot Modeling and Control, Second Edition, Wiley India Edition, New Delhi., Feb, 2020.
5. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Wiley Press, Dec. 2019.

22MC002 ROBOT CONTROL USING ROS 3 0 0 3

Course Objectives

- To understand the concepts of ROS data types and ROS communication.
- To implement the robot model in simulation and visualization of motion and data in ROS.
- To develop the mobile robot navigation algorithm and trajectory control for the industrial robot arm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Implement basic ROS nodes, topics, and services in a robotic system to facilitate communication between different modules.
2. Demonstrate the simulation and visualization of sensor data (e.g., LIDAR or camera data) in the ROS platform.
3. Use image processing concepts and integrate OpenCV with ROS for robot perception.
4. Implement a motion control algorithm to implement localization and navigation in autonomous mobile robots
5. Develop controllers (position, velocity, force) for robot arms in ROS, ensuring accurate movement and task execution.

Articulation Matrix

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

UNIT I **9 Hours**

ROS FOUNDATIONS

ROS concepts ROS data types and variables ROS packages Nodes ROS tools ROS message ROS communication: ROS topic, Service and action ROS custom messages Parameter server.

UNIT II **8 Hours**

ROBOT VISUALIZATION IN ROS

2D Robot simulator Modeling Unified Robot Description format URDF Gazebo Joint controller Building and simulating mobile robot model Coordinate transforms Rviz Displaying sensor value in RVIZ.

UNIT III **8 Hours**

ROBOT PERCEPTION

Transformation of camera coordinates Camera Calibration Opencv in ROS Depth Camera Simple point cloud node Loading, Saving and Interpreting point cloud images Object finder.

UNIT IV **10 Hours**

MOBILE ROBOT NAVIGATION IN ROS

Path Trajectories State publishing Robot state estimation Odometry Fusion of Odom, GPS and Inertial sensing unit Fusion of odometry and LIDAR Differential drive steering algorithms Map and path Making Move base Navigation stack.

UNIT V **10 Hours**

ROBOT ARM IN ROS

One-DOF Robot model Two-DOF Robot Model Position controller Velocity controller Force controller Trajectory message for Robot arms Trajectory Interpolation Forward kinematics Inverse kinematics Motion planning: Cartesian and Join space.

Total: 45 Hours

Reference(s)

1. Wyatt S. Newman, A Systematic Approach to Learning Robot Programming with ROS, CRC Press, 2018.
2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners:Robotics Programming Made Easy, Apress; 1st ed. edition, 2018.
3. Anis Koubaa, Robot Operating System (ROS) The Complete Reference, Studies in Computational Intelligence, Springer, Volume 778, 2019.
4. Morgan Quigley, Brian Gerkey, and William D. Smart, Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O Reilly Media, Inc, 2018.

22MC003 DRONE TECHNOLOGY 3 0 0 3

Course Objectives

- To understand the evolution and the basic structure of drone technology
- To analyze the characteristics of drone and its applications.
- To apply the method of operating drone in a desired trajectory.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Implement the fundamental ideology about exploring the potential of the drone technology
2. Use advanced ICT solutions for the programming of drones and establish the parameter for flying
3. Outline the precaution and pre-flight maintenance for the safety use of drones.
4. Integrate guidance and trajectory control algorithm to navigate the drone in projected path

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO DRONE TECHNOLOGY

Basic terminology. Drones principles of Flight Historical Development Classifications overview and technical characteristics of drone Components Laws & regulations level of autonomy assembly of drone.

UNIT II **9 Hours**

DRONE PROGRAMMING AND FLYING OPERATION

Drones configurations The methods of programming drone Multirotor Stabilization Flight modes Concept of operation for drone Flight modes Drone controls Flight operations management tools.

UNIT III **9 Hours**

HARDWARE AND SOFTWARE SUPPORT

Specifications and Characteristics of Motors and Batteries Selection of Propellers Autopilot system and operations- servos and actuators- Open source, DO178C and ARP4754A software design standards.

UNIT IV **9 Hours**

DRONE MAINTENANCE

Mission control Fully Autonomous take-off and landing system Types of sensors and data transmission Telemetry and Tracking system Integrated Global positioning system Maintenance Scheduled Maintenance Pre flight Inspections Unscheduled Maintenance Batteries and Payloads.

UNIT V **9 Hours**

DRONE CONTROL SYSTEM

Path planning algorithm waypoint trajectory guidance method Obstacles Avoidance Techniques Functional block of lateral and longitudinal guidance Structure of Ground control network system Flight Test.

FOR FURTHER READING Drone commercial applications Case studies in the drone industry 3D mapping and aerial cinematography

Total: 45 Hours

Reference(s)

1. Mirosaw Adamski, "Power units and power supply systems in UAV", New Edition, Taylor and Francis Group publishers, 2014.
2. Reg Austin, "Unmanned Air Systems: UAV Design, Development and Deployment"First Edition, Wiley Publishers, 2015.
3. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280- 316X. 34, 2002.
4. Droneprep, "Unmanned Aircraft Systems Logbook for Drone Pilots & Operators", Create Space Independent Publishing Platform, Latest Edition, 2015.

22MC004 ROBOTIC VISION 3 0 0 3

Course Objectives

- To transform the images and videos acquired by cameras mounted on robots into representations like features and optical flow.
- To determine 3D poses from 2D images for augmented reality tasks and visual odometry for robot localization
- To design robot vision systems that avoid collisions, safely work with humans and understand their environment.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Demonstrate the image formation and camera calibration principles of a pin hole camera model
2. Use the edge detection and transformation techniques involved in projective transformation.
3. Compute the camera pose mounted on the end-effector using the point correspondences
4. Demonstrate a 3D reconstruction and bundle adjustment techniques using the point correspondences
5. Select the appropriate visual servoing techniques and SLAM algorithms for navigation of robots

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

UNIT I **9 Hours**

INTRODUCTION TO IMAGE FORMATION

Elements of Visual Perception Image Sampling and Quantization Image transformations and geometric operations Image Formation Camera Models, Pin-Hole Camera Models, Focal length and Dolly zoom effect, Intrinsic Extrinsic parameters, Rotation & translations, Camera Calibration.

UNIT II **9 Hours**

PROJECTIVE TRANSFORMATIONS

Homogeneous transformation, Projective transformation, vanishing points, Cross ratio, Two view soccer metrology, Geometrical Transformation, Affine, Protective, Fourier Transforms, Image Convolution, Edge Detection, Image Convolution.

UNIT III **9 Hours**

POSE ESTIMATION

Visual features, Triangulation, Singular Value Decomposition, Point Correspondences, SIFT, SURF, Triangulation, Camera Pose Estimation, Pose from 3D point Correspondences, Pose from 3 Point correspondences P3P, Pose from n point correspondences (PnP).

UNIT IV **9 Hours**

MULTI-VIEW GEOMETRY

Epipolar Geometry, RANSAC, Non linear least squares, Optical flow 2D point correspondences, 3D velocities from optical flow, 3D motion and structure from multiple views, Fundamental & Essential matrix, Bundle Adjustment, 3D Reconstruction using stereo camera and multi-views.

UNIT V **9 Hours**

VISUAL SERVOING AND SLAM

Vision-based control, Position-based Visual Servoing, Image-based Visual Servoing, Visual Odometry, Simultaneous Localization and Mapping.Initialization, Tracking, Mapping, geometric SLAM formulations (indirect vs. direct error formulation, geometry parameterization, sparse vs. dense model, optimization approach).

Total: 45 Hours

Reference(s)

1. Peter C., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011
3. Horn B.K.P., Robot Vision, MIT Press, 1986.
4. An Invitation to 3-D Vision: From Images to Geometric Models, Yi Ma, Stefano Soatto, Jana Kosecka, and Shankar Sastry,Interdisciplinary Applied Mathematics #26, Springer, 2003.
5. Siegwart R. and Nourbakhsh I.R., Introduction to Autonomous Mobile Robots, MIT Press, Cambridge, MA, USA, 2004.Godfrey O., Mechatronics: Principles and Applications, Elsevier, 2005.
6. Lewis F.L., Dawson D.M. and Abdallah C.T., Robot Manipulator Control: Theory and Practice, Marcel Dekker Inc., NY, USA, 2004

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22MC005 MEDICAL ROBOTICS 3 0 0 3

Course Objectives

- To understand the fundamental concepts in robotics and robotic control.
- To understand the applications of medical robotics in a range of scenarios including rehabilitation and surgery.
- To get adequate knowledge about links between robotic theory and the design of medical robots

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate medical robots based on the concept of navigation and motion replication
2. Assess the robot design concepts used in MIS, considering factors like precision, portability, and flexibility in relation to patient safety.
3. Compare the medical imaging modalities (MRI, X-ray, CT, etc.) with robotic systems to guide surgical interventions with precision.
4. Evaluate the use of EMG, EEG, and ECG machines in monitoring rehabilitation progress and assess the effectiveness of manipulability analysis in rehabilitation robotics
5. Differentiate between various haptic feedback systems used in exoskeletons and robotic catheters, analyzing their impact on user experience and effectiveness in bio-medical applications.

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to medical robotics (applications and paradigms), Different types of medical robots, Basic kinematics concepts (forward, inverse, remote center of motion), Basic control concepts (impedance, admittance).

UNIT II **9 Hours**

MINIMALLY INVASIVE SURGERY (MIS)

Human-machine interfaces, Teleoperation, Cooperative manipulation, Port placement for MIS, Robot design concepts, Video images in MIS, ARVR in MIS.

UNIT III **9 Hours**

IMAGE-GUIDED INTERVENTIONS

Medical imaging modalities (e.g., MRI, US, X-ray, CT), Robot compatibility with medical imagers, Image segmentation and modelling, Tracking devices, Frames and transformations, Surgical navigation, Calibration, Rigid and non-rigid registration, Radiosurgery.

UNIT IV **9 Hours**

REHABILITATION ROBOTICS

Exoskeletons Development and Control. Human Hand Biomechanics, Manipulability analysis, Redundancy resolution. EMG, EEG and ECG Machines.

UNIT V **9 Hours**

BIO-MEDICAL ROBOTICS

Haptic Augmentation in Exoskeletons, Robotic Catheters for percutaneous interventions, Unsupervised leaning for mapping in Bio-Robots

FOR FURTHER READING

Position Control of a Hand Exoskeleton using Subjects Intention, Human Hand Biomechanics Study.

Total: 45 Hours

Reference(s)

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, Wiley Publishers, 2006.
2. Paula Gomes, Medical robotics- Minimally Invasive surgery, Woodhead, 2012.
3. AchimSchweikard, Floris Ernst, Medical Robotics, Springer, 2015.
4. Jocelyne Troccaz, Medical Robotics, Wiley-ISTE, 2012.
5. VanjaBonzovic, Medical Robotics, I-tech Education publishing,Austria,2008.
6. Daniel Faust, Medical Robots, Rosen Publishers, 2016. 5. Jocelyne Troccaz, Medical Robotics, Wiley, 2013.

22MC006 MOBILE ROBOTICS 3 0 0 3

Course Objectives

- To apply the forward and inverse kinematics of wheeled robot with Manoeuvrability
- To understand and demonstrate gaussian filters , Particle filter with Velocity, odometry model of mobile robot.
- To plan and control the path of mobile robot using path planning algorithm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select appropriate robot locomotion technique based on the terrain and the navigation characteristics.
2. Apply forward and inverse kinematics and DH convention for estimating the position and orientation of mobile robot .
3. Use the gaussian filters to probablistically estimate the state of the mobile robot.
4. Apply robot localization techniques to navigate the mobile robot in an unknown environment.
5. Develop path planning and motion control algorithms for navigating mobile robots.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MOBILE ROBOTS

Locomotion: Key issues of locomotion - Legged mobile robots- configuration and stability - Wheeled mobile robot: design space and case studies - Aerial mobile robots: Aircraft configuration-VTOL (IO control).

UNIT II **9 Hours**

KINEMATICS

Kinematic Models and Constraints Robot Position Forward and Inverse Kinematic Models Manoeuvrability Mobile Robot Manoeuvrability,Mobile Robot workspace, Motion Control.

UNIT III **9 Hours**

PROBABILISTIC ROBOTICS

Introduction Uncertainty and need of Probability Theory Recursive State Estimation- Bayes filters Gaussian Filters Kalman Filter EKF UKF Information Filter Non parametric Filters Particle Filters Robot Model: Velocity Motion Model and Odometry Motion Model

UNIT IV **9 Hours**

LOCALIZATION

Markov Localization, EKF Localization Algorithm EKF Localization with Unknown Correspondences Multi Hypothesis Tracking. Mapping Occupancy Grid Mapping Learning Inverse Measurement Models SLAM EKF with known and Unknown Correspondence The Graph SLAM Fast SLAM.

UNIT V **9 Hours**

PLANNING AND MOTION CONTROL

Introduction-Path planning overview Global path planning Algorithm local path planning - Road map path planning Cell decomposition path planning-Potential field path planning Obstacle avoidance Path control.

Total: 45 Hours

Reference(s)

1. Karsten Berns, Ewald Von Puttkamer , Autonomous Land Vehicles Steps towards Service Robots, Vieweg Teubner Springer, 2009.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , Principles of Robot Motion-Theory, Algorithms, and Implementation, MIT Press, Cambridge, 2005.
3. Bruno Siciliano, Oussama Khatib , Springer Hand Book of Robotics, Springer, 2008

22MC007 CNC TECHNOLOGY **3 0 0 3**

Course Objectives

- To understand the construction and principle of CNC machines
- To generate simple programs for CNC turning and machining centres

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the evolution and working principle of CNC machine tools with its relevant applications
2. Demonstrate the basic structure, construction, working and control of CNC machines over conventional units
3. Compute a real time program for producing desired products using CNC machines
4. Compare the different tooling and work holding device for tools and work pieces
5. Outline the maintenance and troubleshooting techniques in CNC Machines

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO CNC MACHINE TOOLS

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept classification of CNC Machines turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators Computer Aided Inspection

UNIT II **9 Hours**

STRUCTURE OF CNC MACHINE TOOL

CNC Machine building, structural details, configuration and design, guide ways Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion Screw and nut, re circulating ball screw, planetary roller screw, re circulating roller screw, rack and pinion, spindle assembly, torque transmission elements gears, timing belts, flexible couplings, Bearings

UNIT III **9 Hours**

CNC PROGRAMMING

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, parametric programming, machining cycles, programming for machining, generation of CNC codes from CAM packages, CNC controllers

UNIT IV **9 Hours**

TOOLING AND WORK HOLDING DEVICES

Introduction to cutting tool materials Carbides, Ceramics- Cubic Boron Nitride, Polycrystalline Cubic Diamond- insert selection codes - PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC

UNIT V **9 Hours**

CNC MAINTENANCE AND TROUBLE SHOOTING

Warnings-Check operation, Replacement, Parameters, Daily Maintenances - Caution, Note, Alarms, Maintenance Parts, Parameters. Trouble shooting-Causes and Remedies for failures Machine position, Reference Position, Manual operation, Automatic operation, Jog Operation, Feed rate, Spindle Speed, LCD Display, Abnormal Servo System

Total: 45 Hours

Reference(s)

1. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017
2. Warren S.Seamers, Computer Numeric Control, Fourth Edition Thomson Delmar, 2002
3. P. N. Rao and N. K. Tiwari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publishing company, New Delhi 2012
4. Tilak Raj, CNC technology & programming, Dhanpat Rai publishing company(p) ltd., N Delhi,2014
5. P. Radhakrishnan, Computer Numerical Control Machine & Computer Aided Manufacturing, New Academic Science Limited,England 2014
6. M. Adithan & B. S. Pabla, CNC Machines, New Age International Publishers , N Delhi, 2018

22MC008 COMPUTER INTEGRATED MANUFACTURING 3 0 0 3

Course Objectives

- To introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- To provide knowledge on Group Technology and Computer Aided Process Planning
- To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems.
- To learn the various CIM implementation and data communication techniques
- To provide knowledge on the concept of Manufacturing automation protocol, Technical office protocol and database terminology.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Assess CAD/CAM integration for changing manufacturing and management scene
2. Construct a machine cell using the concepts of Group Technology and Computer Aided Process Planning
3. Select the suitable material handling and storage system for Flexible Manufacturing Systems
4. Justify the suitable CIM implementation and data communication techniques
5. Outline various protocols and database terminology in CIM

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems, manufacturing automation protocol, introduction to CAD/CAM integration.

UNIT II **10 Hours**

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. Benefits of G.T cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT III **9 Hours**

SHOP FLOOR CONTROL AND FMS

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection system. FMS- components of FMS- types -FMS workstation- material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

System modelling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) -manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) - topology -LAN implementations - network management and installations.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol (MAP/TOP).Development of databases database terminology architecture of database systems data modeling and data associations -relational data bases database operators advantages of data base and relational database

Total: 45 Hours

Reference(s)

1. Mikell P Groover,Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD,CAM,CAE systems, Addison Wesley, United States of America, 1999
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003
4. Radhakrishnan P, Subramanyan S and Raju V, CAD,CAM,CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000

22MC009 ADDTIVE MANUFACTURING 3 0 0 3

Course Objectives

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes
- To impart knowledge on powder based AM processes.
- To introduce the concept of open source 3D printers and rapid tooling
- To expose the emerging trends and applications of Additive Manufacturing technology

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Implement the generic steps and classification of Additive Manufacturing processes. 2. Select the suitable material and AM process based on applications.
2. Select the suitable material and AM process based on applications
3. Find the suitable AM process to fabricate metallic components.
4. Design their own open source 3D printer based on application
5. Outline the reverse engineering techniques for developing prototype

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

UNIT I **7 Hours**

INTRODUCTION

Needs Impact of AM and Rapid 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 - RP Benefits - Classification of RP systems

UNIT II **7 Hours**

LIQUID POLYMER AND SOLID BASED SYSTEMS

Stereolithography Apparatus (SLA), Digital Light Projection (DLP), Continuous Liquid Interface Production (CLIP), Photo polymerization process, Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Materials and Applications.

UNIT III **10 Hours**

POWDER BASED SYSTEMS

Selective Laser Sintering (SLS), Color Jet Printing, Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS)- Working Principle, Construction, Process Variables, Materials and Applications

UNIT IV **11 Hours**

OPEN SOURCE PRINTER AND RAPID TOOLING

Concept of open source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber moulding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications

UNIT V **10 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering - Application of CMM, Laser scanner, CT and MRI scan in acquiring point data - Software for STL file processing. Application of Rapid prototyping in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP systems

Total: 45 Hours

Reference(s)

1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
2. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
3. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
4. L.W. Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.
5. www.all3dp.com, www.3dprintingindustry.com, www.reprap.org, www.thingiverse.com

22MC010 NON - DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To understand the basic principles of various NDT methods
- To be aware of applications and limitations of the NDT techniques
- To know the different types of service and process defects

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Use surface NDT techniques to carry out various testing & inspection in accordance with the established procedures
2. Demonstrate eddy current testing procedures for non-destructive testing
3. Find principles of magnetism to investigate the service and processing defects
4. Choose right radiographic techniques and X-Rays for testing
5. Compare ultrasonic testing as an NDT technique to investigate defects

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

UNIT I **9 Hours**

VISUAL INSPECTION AND DYE PENETRANT TESTING

Introduction to NDT, Scope and advantages of NDT, Comparison of NDT with DT, Classifications of NDT. Equipment(s) used for visual inspection - Magnifying Glass, Magnifying Mirror, Microscope, Borescope, Endoscope. Liquid penetration testing - Introduction, Principle, Equipment, Procedures, Characteristics of penetrants. Developers - Evaluation - Hazards & Precautions, Advantages, Limitations and Applications.

UNIT II **9 Hours**

EDDY CURRENT TESTING

Eddy Current Testing- Principle, Advantages, Disadvantages, Factors Affecting Eddy Current Response Material Conductivity Permeability - Frequency- Geometry-Proximity (Lift off)-Faraday"s Law, Lenz"s law, Typical Applications, Limitations, Types of Probes.

UNIT III **9 Hours**

MAGNETIC PARTICLE TESTING

Principle of Magnetic Particle Testing-different methods to generate magnetic fields -Magnetic Particle Testing Equipment- Magnetic Particle Testing Procedures Method of De-Magnetization- Magnetic Particle Medium-Evaluation of Indications and Acceptance Standards- magnetic particle test-applications, advantages and limitations

UNIT IV **9 Hours**

RADIOGRAPHIC TESTING

X-Ray properties and atomic scattering, X-ray radiography principle, equipment & methodology - Type of Industrial Radiation sources and Application-Radiographic exposure Factors and Technique - X-Ray Equipment- Radiographic Procedure - Radiograph Interpretation, Radiography Image Quality- Indicators Radiographic Techniques- Film Processing-Methods of Viewing Radiographs- Radiographic Testing Procedures for welds. Precautions against radiation hazards

UNIT V **9 Hours**

ULTRASONIC TESTING

Introduction, Principle of operation Type of Ultrasonic Propagation- Ultrasonic probes. Types of Transducers -Ultrasonic Testing Techniques. Method for Evaluating Discontinuities-Ultrasonic Testing Procedures for different component- advantages and limitations, Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements.

Total: 45 Hours

Reference(s)

1. J Prasad, C G K Nair, Non-Destructive Testing and Evaluation of Materials, Tata McGraw Hill Education Private Limited, 2017
2. Baldev Raj, M. Thavasimuthu, and T. Jayakumar, Practical Non-destructive Testing, Alpha Science International Ltd, 2007
3. American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th Ed, Metals Park, 1989
4. Bray, Don.E and Stanley, Roderic.K, Nondestructive Evaluation: A Tool in Design, Manufacturing, and Service. Revised, CRC Press New York, Edition, 1997
5. www.ndt-ed.org
6. https://nptel.ac.in/courses/112105125/

22MC011 DESIGN FOR MANUFACTURING AND ASSEMBLY 3 0 0 3

Course Objectives

- To learn the way of specifying geometric dimensioning and tolerancing in engineering drawing
- To familiarize the design considerations for designing components for the casting, welding and forming processes.
- To familiarize the design guidelines while designing components which are manufacturing by different machining processes.
- To learn the factors affecting easy assembly of parts into a final product
- To impart knowledge about the product life cycle assessments and environmental impact of materials,manufacturing methods and the way to minimize it

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Find geometric dimensioning and tolerancing techniques in engineering drawing
2. Select appropriate design considerations to minimize difficulty to produce components by casting, welding and forming processes
3. Use the design for manufacturing concept to reduce machining time and manufacturing cost
4. Outline and design the parts for easy assembly using DFA guidelines
5. Organize the components by considering the product life cycle and its environmental impact

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

UNIT I **10 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. Geometric Dimensioning and Tolerancing - Location, Form, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, Parting line - Redesign of castings based on parting line considerations, Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components

UNIT III **8 Hours**

DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for Manufacture Guidelines - Design features to facilitate machining - Drills - Milling cutters -Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area Simplification by separation - Simplification by amalgamation. Design for Manufacture: Machinability, Economy, Clampability, Accessibility, Assembly. Redesign for Manufacture - Examples.

UNIT IV **8 Hours**

DESIGN FOR ASSEMBLY

Design for Assembly(DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours**

DESIGN FOR ENVIRONMENT

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&Ts (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards.

FOR FURTHER READING

Case studies - Design components for casting, welding, forging and machining processes. Design components for minimizing environmental impact.

Total: 45 Hours

Reference(s)

1. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design,McGraw-Hill Professional, New Delhi, 2011
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973
3. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 1974.
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw-Hill Publications, New Delhi, 2000.
6. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.

22MC012 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To understand the use of forecasting, control of inventory, process of routing and scheduling for improving productivity
- To build and solve linear programming problem
- To analyse deterministic and probabilistic models of problems related to networks and queuing

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the ways of improving productivity by job design, work study, ergonomics, forecasting techniques and following safety
2. Assess inventory control techniques and the need for material requirement planning
3. Find sequencing of jobs with two and more machines and also compute the characteristics of single server queuing models
4. Compare linear programming problems and find the optimum solution.
5. Outline the network model and identify the critical path of deterministic and probabilistic models

Articulation Matrix

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

UNIT I **9 Hours**

PRODUCTION PLANNING AND CONTROL

Productivity - Productivity index -Productivity measurement - Job design - Job standard - Work study - Method study - Operation process chart - Motion study - Motion economy - SIMO chart - Work measurement - PMTS - Ergonomics - Industrial safety: losses due to accidents, causes, preventive measures - Forecasting - Types - Accuracy of forecast -Sales forecasting techniques - Time series method: simple moving average, weighted moving average, exponential smoothing. Production control dispatching

UNIT II **9 Hours**

INVENTORY CONTROL

Inventory control - Purpose - Inventory costs - EOQ - Deterministic models - Shortage model - Classification: ABC analysis, FSN analysis - Material Requirement Planning (MRP), KANBAN technique, lean manufacturing, Supply chain management - Material Handling Functions, Principles, Engineering and economic factors, Material handling equipment selection, maintenance and its types.

UNIT III **9 Hours**

SCHEDULING AND QUEUING

Introduction -Rules - Factors affecting - Master schedule - Gantt chart - Sequencing problem: Models with n jobs with 2 machines Models with n jobs with 3 machines - Queuing models - Queuing systems and structures Notation - Parameter - Poisson input - Exponential service - Constant rate service - Infinite population -Single server models

UNIT IV **9 Hours**

LINEAR PROGRAMMING

Introduction - Formulation - Graphical method, Simplex method Artificial Variable techniques: Big M method - Transportation Problems: North West corner method, least cost method, Vogel"s approximation method - MODI method - Assignment problems with Hungarian algorithm

UNIT V **9 Hours**

NETWORK MODELS

Network models - Shortest route - Minimal spanning tree - Maximum flow models - Project network - CPM and PERT networks - Critical path scheduling

Total: 45 Hours

Reference(s)

1. T. R. Banga, N. K. Agarwal and S. C. Sharma, Industrial Engineering and Management Science, Khanna Publishers, Delhi, 1996
2. Prem Kumar Gupta and D. S. Hira, Operations Research, S. Chand and Co., New Delhi, 2014
3. S. B. Srivastava, Industrial Management, I. K. International Publishing House Pvt. Ltd., New Delhi, 2012
4. Hamdy A. Taha, Operation Research: An introduction, Pearson Publications., New Delhi, 2010
5. Frederick S. Hiller and Gerald J. Liberman, Operations Research: Concepts and cases, Tata McGrawHill Publishing Company Pvt Ltd., New Delhi, 2010

22MC013 ELECTRIC AND HYBRID VEHICLES 3 0 0 3

Course Objectives

- To introduce fundamental concepts and specifications of electric and hybrid vehicles
- To acquire knowledge technologies related to electric, hybrid and fuel cell powered vehicles
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the current scenario of demand for fossil fuels, effects of automobile pollution and strategy of next generation vehicles
2. Find the requirements of Electric Drive train for hybrid and electric vehicles
3. Select appropriate electric motor and drive controls for EVs and HEVs.

4. Outline the performance of energy storage systems in electric and hybrid vehicles
5. Compare appropriate Fuel Cell Technology for EVs and HEVs

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Usage Pattern of Automobiles in cities and highways, Air Pollution: NOx, CO, HC, PM emission, Global Warming Health Impacts, Petroleum Resources, Induced Costs, Importance of Different Transportation Development, Strategies to Future Oil Supply, Strategies for Next Generation Vehicles.

UNIT II **9 Hours**

ELECTRIC AND HYBRID VEHICLES

Configuration Layouts of early EVs and modern EVs, merits and demerits, Concept of Hybridization, Hybrid electric drive trains - types of hybrid drive train topologies, Speed & Torque Couplings, Types of HEVs, Regenerative braking strategies, Start/Stop in EVs and HEVs, Merits and demerits.

UNIT III **9 Hours**

PROPULSION SYSTEM FOR EVS

Basic concept of electric traction, Power-Torque Characteristic curves, Selection of Electric motors, Motors types: DC motor drives, induction motor drives, brushless DC PM motor drives, Switched Reluctance motor drives, starter/alternator, Electric Control Drives.

UNIT IV **9 Hours**

ENERGY MANAGEMENT SYSTEM FOR EVS

Energy storage requirements in HEVs and EVs, Energy storage techniques - battery based energy storage: Engine starter batteries, Traction Batteries, Super capacitor based energy storage and flywheel based energy storage, Hybridization of different energy storage devices.

UNIT V **9 Hours**

FUEL CELL TECHNOLOGIES

Fuel cell electric vehicles-operating principle, Fuel cell technologies- alkaline fuel cell- proton exchange Membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Fuel reformer, Hydrogen storage systems.

Total: 45 Hours

Reference(s)

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2018.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Boca Raton: CRC Press, 2011
3. AuliceScibioh M. and Viswanathan B., Fuel Cells Principles and Applications, India: University Press, 2009.
4. Barbir F., PEM Fuel Cells: Theory and Practice, Burlington: Elsevier, 2012.
5. James Larminie and John Loury, Electric Vehicle Technology-Explained, New York: John Wiley & Sons Ltd., 2012.
6. https://nptel.ac.in/courses/108103009/

22MC014 AUTONOMOUS AND CONNECTED VEHICLES 3 0 0 3

Course Objectives

To impart knowledge on autonomous vehicle and driver assistant systems To understand the key aspects of In-Vehicle Infotainment System
To understand the operating strategies of technologies under autonomous vehicles

Programme Outcomes (POs)

PO2. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them PO3. Design and develop automobile systems , sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

PO5. Use appropriate techniques , modern engineering/IT/ product development tools and mathematical /computer-based models with an understanding of the limitations

PSO1. An ability to design, analyze and find the solutions for automotive related problems. PSO2. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Gain knowledge on different driver assistant system of autonomous vehicle and their applications
2. Understand the Radio communication technologies for Intelligent Vehicles
3. Discuss the key trends and concepts of In Vehicle Infotainment System.
4. Explain the various security systems associated with vehicle system
5. Implement the modern day technologies of autonomous vehicles

Articulation Matrix

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

UNIT I **9 Hours**

AUTONOMOUS DRIVING TECHNOLOIES -INTRODUCTION

Levels of Driving Automation, Architecture for Autonomous System – Hardware and Software Architecture, Computer vision, Deep learning, Sensor fusion – localization - path planning – decision and Control - System integration.

UNIT II **9 Hours**

RADIO COMMUNICATION AND INTELLIGENTTRANSPORTATION-SYSTEMS

Introduction – ITS communication systems, Multimedia communication in a car, Current ITS communication systems and services - Inter-vehicle communication system - Road-vehicle communication system - Device technologies.

UNIT III **9 Hours**

FUNDAMENTALS OF INFOTAINMENT SYSTEM

Introduction to In Vehicle Infotainment (IVI) systems, Use of operating systems in IVI - GENIVI Alliance-Tuner- AM/FM - XM/Sirrus - DAB/DMB - Software Defined Radio - Ensemble - Traffic Announcements - Spread Spectrum, Multimedia: Types of Media. Navigation- Points of Interests - Routes - Waypoints - Dead Reckoning position, Traffic Info - GLONASS - GNSS - RTK - GPS - and SBAS/GBAS, INS - System Architecture – Design Patterns - Proxies - Adaptors - Interfaces - Singleton - Factory method.

UNIT IV **9 Hours**

TELEMATICS & SECURITY SYSTEMS

Telematics-Global positioning systems - geographical information systems - navigation systems - automotive vision system - road recognition - driver assistance systems. Security Systems- Vehicle Immobilzers - Anti theft technologies - smart card system - number plate coding.

UNIT V **9 Hours**

ADAVANCED DRIVER ASSISTANCE AND SAFETY SYSTEM

Active Safety Systems -and Passive Safety Systems - Advanced Driver Assistance Systems (ADAS)- Combining computer vision techniques as pattern recognition - feature extraction - learning - tracking - 3D vision to assist the driving activity. Examples of assistance applications- Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles.

Total: 45 Hours

Reference(s)

1. Intelligent Vehicle Technologies - Ljubo Vlacic, Michel Parent and Fumio Harashima, Butterworth-Heinemann publications, Oxford, 2001.
2. William B Ribbens , "Understanding Automotive Electronics", Butter worth Heinemann Woburn, 2012.
3. Yunpeng Wang, Daxin Tian, Zhengguo Sheng, Wang Jian , "Connected Vehicle Systems: Communication, Data, and Control", 2nd Edition , CRC publisher, 2017.
4. Ronald K Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014
5. Robert Bosch,Automotive Hand Book, Warrendale, PA: SAE International, 2014
6. Hong Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.

22MC015 AUTOMOTIVE INFOTRONICS 3 0 0 3

Course Objectives

- To understand the technologies relevant to intelligent vehicle systems
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO5. 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.
PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Describe the principle of operation and application of the components in intelligent ground vehicles
2. Demonstrate knowledge on intelligent sensors, vehicle control, navigation, and communications systems
3. Find the recent trends in vehicle Comfort System
4. Design the various security systems associated with vehicle system
5. Outline recent trends and intelligent technologies associated with modern day vehicles

Articulation Matrix

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

UNIT I **9 Hours**

DRIVER ASSISTANCE SYSTEMS

Advanced Driver Assistance System Types/Levels, Driver information, driver perception, driver convenience, driver monitoring, general vehicle control, longitudinal and lateral control, collision avoidance, vehicle monitoring.

UNIT II **9 Hours**

TELEMATICS

Global positioning system, geographical information systems, navigation system, architecture, automotive vision system, road recognition.

UNIT III **9 Hours**

COMFORT SYSTEMS

Adaptive cruise control system, active suspension system, power steering, collapsible and tiltable steering column, power windows, eight way seating system and climate control system, Adaptive Lighting Systems , Automatic Wiper system

UNIT IV **9 Hours**

SECURITY SYSTEMS

Anti-theft technologies mechanical, electromechanical and electronic immobilizers, alarm system, stolen vehicle tracking system, remote keyless entry, smart card system, number plate coding.

UNIT V **9 Hours**

INTELLIGENT AND SAFETY SYSTEMS

Lane Departure Warning System, Adaptive Headlight Systems, Day time running lights (DRL), Active and Passive Safety, Airbags, Seat Belt Tightening System, Forward Collision Warning Systems, Child Lock, Antilock Braking System, Vehicle communication-Car to X communication.

Total: 45 Hours

Reference(s)

1. Ronald K Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014
2. Ozguner, TankutAcarman, Keith Redmill, Autonomous Ground Vehicles, London: Artech House Publishers, 2011.
3. Robert Bosch,Automotive Hand Book, Warrendale, PA: SAE International, 2014
4. Hong Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.

22MC016 AUTOMOTIVE COMMUNICATION SYSTEMS 3 0 0 3

Course Objectives

- To understand concept of autonomous and connected vehicle
- To learn about sensor technology of automated vehicle
- To understand about computer vision and deep learning
- To acquire knowledge on localisation and path planning
- Become familiar with the concept of connected vehicles

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Assess the evolution of automotive electronic and connected vehicle concepts
2. Find sensors for automotive application
3. Use knowledge of Computer Vision and Deep learning in autonomous vehicle

4. Carryout fundamentals of Localization and Path planning in autonomous vehicle
5. Outline fundamentals of connected vehicle

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to the Concept of Automotive Electronics-History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Advanced Driver Assistance Electronic Systems Basic Control System Theory applied to Automobiles-Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT II **9 Hours**

SENSOR TECHNOLOGY FOR AUTOMATED VEHICLES

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT III **9 Hours**

COMPUTER VISION AND DEEP LEARNING

Introduction, Computer Vision: - Computer Vision Fundamentals, Deep Learning:- Neural Networks, Deep Neural Networks, Convolutional Neural Networks, Keras ,TensorFlow, Sensor Fusion:- Kalman Filters

UNIT IV **9 Hours**

LOCALISATION AND PATH PLANNING

Introduction to Localization- Motion Models, Particle Filters, Implementation of a ParticleFilter, Path Planning: -search, prediction, behaviour planning, trajectory generation, Control-PID, System Integration-ROS Driverless Car Technology: - Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

UNIT V **9 Hours**

CONNECTED CAR TECHNOLOGY

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Wireless Security OverviewConnected Car Display Technology- Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, Warning Technology-Driver Notification

Total: 45 Hours

Reference(s)

1. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner , Autonomous Driving: Technical, Legal and Social Aspects, Springer,2016
2. Hod Lipson, Melba Kurman,Driverless: Intelligent Cars and the Road Ahead,MIT press, 2016
3. Michael E. McGrath , Autonomous Vehicles: Opportunities, Strategies,and disruptions, 2016
4. Vivekwadhwa , Alex salkever, The driver in the driverless car, 2017
5. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson- Delmar Learning, ISNB 1-4018-8659-0, 2006
6. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN 1-4018-4339-5, 2003

22MC017 VEHICLE CONTROL SYSTEMS 3 0 0 3

Course Objectives

- To acquire knowledge on intelligent systems, focusing on those in-vehicle solutions specifically designed to improve driving and travelling energy efficiency
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems
- To enable evaluation of appropriate methodologies and be aware of the design and implementation issues of advanced techniques

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the importance of modern trends in vehicle System
2. Use the knowledge for selection of sensor and communication protocols for interfacing sensors
3. Show the knowledge for understanding the traffic information in the surroundings

4. Compare the various intelligent systems used in automobiles and entertainment features inside the vehicle
5. Outline the intelligent systems associated with Autonomous vehicle

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

UNIT I **7 Hours**

INTRODUCTION TO INTELLIGENT VEHICLE SYSTEMS

Definition, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance System-Types/Levels, Next Generation Intelligent Vehicles, General Vehicle Control.

UNIT II **10 Hours**

IOT IN AUTOMOBILES

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Real Time Driver Monitor, Geo fencing and Speed Monitoring, Stolen Vehicle Tracking, Biometrics Information for Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation, Introduction to Autonomous Vehicle.

UNIT III **10 Hours**

TRAFFIC SURROUNDINGS

Modelling traffic and driver interactions, Simulation of driver and city interaction, Behavior and driving pattern, simulation of driver and highway interaction, Behavior and driving pattern, Application: Traffic alert - Real time road data on Navigation, Navigation System- Global Positioning System, Geographical Information Systems Architecture, Road Sign Recognition.

UNIT IV **9 Hours**

CONNECTED VEHICLE SYSTEMS

Introduction to CVS, Telematics control system architecture -driver information systems, Vehicle - vehicle interaction using TCS, Current trends in auto industry, In-Vehicle Entertainment System - Mirror link, Web link, App link, Apple Car Play, Android Auto. Application: ecall system - design, functions and limitations.

UNIT V **9 Hours**

AUTONOMOUS VEHICLE COMFORT SYSTEMS AND APPLICATIONS

Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system- ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.

Total: 45 Hours

Reference(s)

1. A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
2. A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.
3. R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.
4. H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.
5. P. C. Cacciabue (Ed.), Modelling Driver Behavior in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems, Springer-Verlag London Ltd, 2007.

22MC018 MACHINE LEARNING FOR AUTONOMOUS VEHICLE 3 0 0 3

Course Objectives

- To understand the Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), and Hardware-in-the-Loop (HIL) concepts.
- To learn about various Real-Time Simulation concepts.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select the mathematical models for components in a system.
2. Use the component models together to model a larger more complex system
3. Design and run Model-in-the-Loop Simulations (MIL).
4. Outline and run real-time simulations for a physical system.
5. Integrate and run Hardware-in-the-Loop Simulations (HIL).

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MODEL-BASED SYSTEM DESIGN

Introduction to Systems Engineering, Systems Engineering and the Life Cycle, Systems Engineering Process Overview, Business Impacts of Systems Engineering, Motor Model, Generator Model, Controller Model, Sim Driveline Introduction.

UNIT II **9 Hours**

REAL-TIME SIMULATIONS

Processor In The Loop Real-Time Simulations, Controller on Freescale Target, Plant on Real-Time Target, Data Collection of Performance. Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), Hardware-in-the-Loop (HIL). Introduction to Simulink Simulations- Implement controller Explore the system response using different control methods, Tune the system, explore system limitations, Understand and refine motor models.

UNIT III **9 Hours**

MODEL VERIFICATION

Test controller on real system Observe system performance, Observe the effect of different contro methods Tune the system. Data Collection of Physical Model Response, Comparison of Physical Plant Response to Model Response.

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS

Automatically Generate Test Schedule to Obtain Data, Run Experiments and Collect Data, Generate Models for Components, Table Lookup, Curve Fits. Design of Experiments to Collect Experimental Data on Motor and Generator.

UNIT V **9 Hours**

MODEL REFINEMENT AND RE-VERIFICATION

Compliance Adjustment of models, Comparison of observed and simulated behaviours, Update Models to Include Measured Data, Comparison of Updated Physical Plant to Model.

Total: 45 Hours

Reference(s)

1. Practical Model-Based Systems Engineering, by Jose L. Fernandez, Carl Hernandez.
2. Effective Model-Based Systems Engineering, John M. Borky, 2018.
3. Model-Based Systems Engineering, A. Wayne Wymore, CRC Press; 1st edition (April 5, 1993)
4. Model Based Systems Engineering: Fundamentals and Methods, Patrice Micouin, Wiley
5. https://in.mathworks.com/.

22MC019 APPLIED 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Develop computational techniques to process and manipulate visual data for improved perception and analysis.
2. Formulate adaptive filtering and restoration methods to enhance image quality under various distortion conditions.
3. Devise intelligent segmentation strategies for accurate object identification and scene interpretation in complex environments.
4. Integrate vision algorithms with real-time frameworks to enable autonomous perception and decision-making of robots.

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

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Steps in Digital Image Processing Components Elements of Visual Perception Image Sensing and Acquisition Image Sampling and Quantization Relationships between pixels Color image fundamentals RGB, HSI models, Two dimensional mathematical preliminaries, 2D transforms DFT, DCT.

UNIT II **9 Hours**

IMAGE ENHANCEMENT

Spatial Domain Gray level transformations Histogram processing Basics of Spatial Filtering Smoothing and Sharpening Spatial Filtering, Frequency Domain. Introduction to Fourier Transform Smoothing and Sharpening frequency domain filters Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III **9 Hours**

IMAGE RESTORATION

Image Restoration degradation model, Properties, Noise models Mean Filters Order Statistics Adaptive filters Band reject Filters Band pass Filters Notch Filters Optimum Notch Filtering Inverse Filtering Wiener filtering

UNIT IV **9 Hours**

IMAGE SEGMENTATION

Edge detection, Edge linking via Hough transform Thresholding Region based segmentation Region growing Region splitting and merging Morphological processing erosion and dilation, Segmentation by morphological watersheds basic concepts Dam construction Watershed segmentation algorithm.

UNIT V **9 Hours**

ROBOT VISION APPLICATION
Basic introduction to Robotic operating System (ROS) Real and Simulated Robots Introduction to OpenCV, OpenNI and PCL, ROS to OpenCV Line following tracking object using optical flow camshaft and meanshift.

Total: 45 Hours

Reference(s)

1. Kenneth R. Castleman Digital Image Processing, Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB, Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing, Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, Digital Image Processing, John Wiley, New York, 2002
5. Milan Sonka et al Image processing, analysis and machine vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

22MC020 FUZZY LOGIC AND ARTIFICIAL NEURAL NETWORK 3 0 0 3

Course Objectives

- To understand fuzzy logic and neural network concepts
- To equip with the latest application of soft computing

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Find the concept of fuzzy set theory and its architectures
2. Use the knowledge based rules and its controller types for the given application
3. Carry out the design for fuzzy knowledge representation and multi objective decision making Controllers
4. Integrate machine learning through neural networks
5. Outline the concept of artificial neural networks and their control applications.

Articulation Matrix

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

UNIT I **9 Hours**

FUZZY LOGIC SYSTEMS

Classical sets-fuzzy sets- fuzzy operation -fuzzy relations - fuzzification - defuzzification - if-then rules-Fuzzy Functions.

UNIT II **9 Hours**

FUZZY SYSTEMS

Membership function-knowledge base - data base - rule base -decision-making logic -fuzzy logic controller: Mamdani and Sugeno-Takagi architecture

UNIT III **9 Hours**

FUZZY RULES AND LOGIC

Representation of fuzzy knowledge - fuzzy inference systems - Fuzzy decision making - Multi Objective Decision Making-Fuzzy logic controller for inverted pendulum.

UNIT IV **9 Hours**

ARTIFICIAL NEURAL NETWORK

Introduction -biological neuron and their artificial models - neuron modeling- learning rules - types ofneural networks - single layer - multi layer feed forward network - back propagation - learning factors.

UNIT V **9 Hours**

NEURAL NETWORKS IN CONTROL APPLICATIONS

Feedback networks - Hopfield networks - Applications of neural networks - Process identification Artificial neuro controller for inverted pendulum

FOR FURTHER READING

ANN in mobile robots navigation and control, Neuro fuzzy approach in machine vision system for parts identification

Total: 45 Hours

Reference(s)

1. Jacek M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, New Delhi,2012.
2. John Yen, Reza Langari, Fuzzy logic Intelligence, control and Information, Pearson Education,1999.
3. C T Jang, J S R Sun and E Mizutani , Neuro Fuzzy and Soft computing, Pearson Education,2006.
4. LaureneFauseett: Fundamentals of Neural Networks, PHI,2004
5. Timothy J.Ross: Fuzzy Logic Engineering Applications, McGrawHill, 2004
6. B. Yagnanarayanan, Artificial Neural Networks, Prentice Hall of India Ltd .,New Delhi.2012.

22MC021 ARTIFICIAL INTELLIGENCE 3 0 0 3

Course Objectives

- To understand the various characteristics of intelligent agents
- To understand the different search strategies in AI
- To represent knowledge in solving AI problems and understand the different ways of designing software agents
- To know the various applications of AI

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict a problem using first order and predicate logic
2. Select appropriate search algorithms for any AI problem
3. Use the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Integrate applications for Natural Learning Process that uses Artificial Intelligence.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction -Definition - Future of Artificial Intelligence - Characteristics of Intelligent Agents - Typical Intelligent Agents - Problem Solving Approach to Typical AI problems

UNIT II **9 Hours**

PROBLEM SOLVING METHODS

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning - Stochastic Games

UNIT III **9 Hours**

KNOWLEDGE REPRESENTATION

First Order Predicate Logic - Prolog Programming - Unification Forward Chaining-Backward Chaining Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information

UNIT IV **9 Hours**

SOFTWARE AGENT

Architecture for Intelligent Agents Agent communication Negotiation and Bargaining -Argumentation among Agents Trust and Reputation in Multi agent systems

UNIT V **9 Hours**

APPLICATIONS

AI applications Language Models Information Retrieval Information Extraction Natural Language Processing Machine Translation Robot Hardware Perception Planning Moving

Total: 45 Hours

Reference(s)

1. Gerhard Weiss, Multi Agent Systems, Second Edition, MIT Press, 2016.
2. Bratko, Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2017
4. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2010
5. M. Tim Jones, Artificial Intelligence: A Systems Approach(Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2009
6. https://nptel.ac.in/courses/106105079

22MC022 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To impart basic knowledge of vision system and its process
- To acquire knowledge on image processing techniques
- To characterize and analyze the image using computational techniques.
- To implement and validate the various vision algorithms for object detections.
- To utilize the vision system for robotics applications

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Select the concepts of vision system and its operations
2. Find the concepts of image capturing and processing techniques.
3. Predict the concept for characterizing and analyzing the features in image
4. Outline a suitable vision algorithm to recognize the object.
5. Integrate computer vision systems with emphasis on applications and problem solving

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF VISION SYSTEM

Introduction to Vision system- Need of vision system, Applications image acquisition illumination techniques Sensor Point, line, planar camera sensor and its characteristics camera calibration sampling and quantization image acquisition hardware

UNIT II **9 Hours**

IMAGE PROCESSING

Segmentation Point operation Neighborhood operation Geometric operations Mathematical morphology Shape and Pattern analysis Image filtering Image convolution Region growing Boundary detection Regionsplitting and merging

UNIT III **9 Hours**

IMAGE ANALYSIS

Inspection location and identification Template matching Decision-theoretic approaches Thresholding Hough transform Histogram analysis Image representation Image display Image Reconstruction Region of Interest template matching stereo reconstruction - color space conversion

UNIT IV **9 Hours**

MACHINE VISION ALGORITHMS

Images and regions Image enhancement image transformations Color detection contour detection line detection circle detection corner detection Edge detection Feature Detection Filters, SIFT, HOG.

UNIT V **9 Hours**

ROBOT VISION APPLICATION

Basic introduction to Robotic operating System (ROS) Real and Simulated Robots Introduction to OpenCV, OpenNI and PCL, ROS to OpenCV Line following - tracking object using optical flow camshaft and meanshift.

Total: 45 Hours

Reference(s)

1. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck,Machine Vision McGraw-Hill, Inc., ISBN 0-07- 032018-7, 1995.
2. Muthukumaran Malarvel, Soumya Ranjan Nayak, Surya Narayan Panda, Prasant Kumar Pattnaik Nittaya Muangnak, Machine Vision Inspection Systems: Image Processing, Concepts, Methodologies and Applications Volume 1, Scrivener Publishing LLC, 2020.
3. E. R. Davies, Machine Vision Theory, Algorithms, Practicalities Elsevier Publication, 3rd Edition - December 22, 2004
4. R.Patrick Goebel ROS by Example: A Do It Yourself Guide to Robot Operating System Volume I A Pi Robot Production, 2012

22MC023 SOFT COMPUTING 3 0 0 3

Course Objectives

- To provide an overview of soft computing techniques
- To provide a strong foundation of neural networks
- To introduce the applications of Fuzzy and Genetic algorithm.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Formulate bio-inspired computational models to address complex problem-solving tasks in machine intelligence.
2. Optimize associative memory techniques and learning mechanisms to enhance pattern recognition and decision-making.
3. Integrate adaptive learning paradigms and uncertainty-handling methods to improve system responsiveness in dynamic environments.
4. Develop optimization models using fuzzy logic and evolutionary algorithms for handling uncertainty and complex constraints.

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

UNIT I **9 Hours**

INTRODUCTION TO NEURAL NETWORKS

Differences between Biological and Artificial Neural Networks Typical Architecture, Common Activation Functions, McCulloch Pitts Neuron, Linear Separability - Hebb Net, Perceptron, Adaline, Madaline Architecture, algorithm, and Simple Applications.

UNIT II **9 Hours**

PATTERN ASSOCIATION

Training Algorithms for Pattern Association Hebb rule and Delta rule, Hetero associative Auto associative and Iterative Auto associative Net, Bidirectional Associative Memory Architecture Algorithm.

UNIT III **9 Hours**

ADAPTIVE RESONANCE AND BACKPROPAGATION NEURAL NETWORKS

ART1 and ART2 - Basic Operation and Algorithm, derivation of earning Rules, Boltzmann Machine Learning - Architecture, Algorithm and Simple Applications.

UNIT IV **9 Hours**

CLASSICAL, FUZZY SETS AND RELATIONS

Properties and Operations on Classical and Fuzzy Sets, Crisp and Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations - Simple Applications.

UNIT V **9 Hours**

GENETIC ALGORITHM

Working principles, Coding, fitness function, GA operators, Differences and similarities between GAs and traditional methods, GAs for constrained optimization, Real-coded Gas - Simple Applications.

Total: 45 Hours

Reference(s)

1. S.N.Sivanandam and S.N.Deepa, Principles of Soft Computing, Wiley India(P) Ltd,2011
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 2011
3. Davis E.Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989
4. Jang.J.S.R., Sun.C.T.andMizutami.E, Neuro fuzzy and Soft computing, Prentice Hall, New Jersey2015

22MC024 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To provide students the knowledge of optimization techniques and approaches. Formulate a real-world problem as a mathematical model and finding solutions
- To enable the students to learn about revised simplex method and sensitivity analysis of LPP.
- To solve networking problems like transportation, Assignment, Maximal flow , Minimum spanning tree and shortest path problems.
- To learn about Decision making under uncertainty and certainty conditions.
- To learn various Queuing models.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Formulate mathematical strategies to optimize resource allocation and decision-making in constrained environments.
2. Implement computational techniques to enhance problem-solving efficiency in large-scale network and routing challenges.

3. Construct systematic approaches for evaluating competitive scenarios and risk-based decision frameworks in uncertain conditions.
4. Develop predictive models for service efficiency and congestion management in complex queuing environments.

Articulation Matrix

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

UNIT I **9 Hours**

LINEAR PROGRAMMING

Introduction to Operations Research assumptions of Linear Programming Problems Formulations of linear programming problem Graphical method. Solutions to LPP using simplex algorithm Two phase method Big M method

UNIT II **9 Hours**

ADVANCES IN LINEAR PROGRAMMING

Revised simplex method primal dual relationships Dual simplex algorithm Sensitivity analysis changes in RHS value changes in Coefficient of constraint Adding new constraint Adding new variable.

UNIT III **9 Hours**

NETWORK ANALYSIS

Transportation problems Northwest corner rule Least cost method Vogels approximation method stepping stone method MODI method Unbalanced transportation Assignment problem Hungarian algorithm Travelling salesman problem project management. Minimum spanning tree problem: prims algorithm, Kruskals algorithm Shortest path problem: Dijkstras algorithms, Floyds algorithm maximal flow problem : Maximal-flow minimum-cut theorem Maximal flow algorithm.

UNIT IV **9 Hours**

DECISION AND GAME THEORY

Decision making under certainty Decision making under risk Decision making under uncertainty Decision tree analysis Introduction to MCDM AHP. Game Theory Two person zero sum games, pure and mixed strategies Theory of dominance Graphical Solution Solving by LP.

UNIT V **9 Hours**

QUEUING THEORY

Queuing theory terminology Single server, multi server limited and unlimited queue capacity limited and unlimited population.

Total: 45 Hours

Reference(s)

1. Philips, Ravindran and Solberg, Operations Research principles and practices, John Wiley, 2007.
2. Ronald L Rardin, Optimisation in Operations Research, Pearson, 2018.
3. Srinivasan.. G, Operations Research Principles and Applications, PHI, 2017.

22MC025 MEDICAL MECHATRONICS 3 0 0 3

Course Objectives

- To recall the human physiological system associated with biological signal acquisition using ECG, EEG, EMG and EOG machines
- To represent the principle function and working of different sensor, transducers, and electronics interfaces such as signal conditioning, recording system related to biomedical field
- To illustrate the functional blocks and operation of some advanced patient monitoring and diagnostic instruments

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Analyze the biological behavior of human cell and relate the resting and action potential associated with the principle of ECG, EEG, EMG and EOG Machines
2. Compare the features of different types of biomedical sensors and transducers
3. Compare the signal conditioning, recording and display systems associated with the biomedical devices.
4. Demonstrate the working of different biomedical patient measurement and monitoring systems
5. Outline the need for various diagnostic instruments used in biomedical instrumentation

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION

Cell structure - electrode - electrolyte interface, electrode potential, resting and action potential - electrodes for their measurement, ECG, EEG, EMG and EOG - - machine description methods of measurement, failures and troubleshooting, Stem cells

UNIT II **9 Hours**

BIO MEDICAL SENSORS AND TRANSDUCERS

Basic transducer principles, Introduction - resistive, inductive, capacitive related to health care, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation, Bio, Nano sensors and application, smart sensors

UNIT III **9 Hours**

MONITORING SYSTEMS AND SIGNAL CONDITIONING

instrument power supply, Input isolation, introduction amplifiers, Arrhythmia and Ambulatory Monitoring Instruments, Foetal Monitoring Instruments, Oximeters, Pulmonary Function Analysers, Clinical Laboratory Instruments, basis of signal conversion and digital filtering, data reduction technique time and frequency domain technique.

UNIT IV **9 Hours**

MEDICAL MEASUREMENT AND HEALTH ASSIST SYSTEMS

Blood pressure measurement: by ultrasonic method plethysonography - blood flow measurement by electromagnetic flow meter, cardiac output measurement by dilution method phonocardiography - vector cardiography. Heart lung machine artificial ventilator - Anesthetic machine - Basic ideas of CT scanner - MRI and ultrasonic scanner - cardiac pacemaker defibrillator patient safety - electrical shock hazards Centralized patient monitoring system

UNIT V **9 Hours**

RECORDERS AND ADVANCED SYSTEMS

Oscillagraphic - galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope. Biotelemetry, Diathermy, Audiometers, Dialyzers, Lithotripsy.

FOR FURTHER READING

Equipment failures and troubleshooting - ECG Analysis Centralized patent monitoring system - Biotelemetry - Bio, Nano sensors and application.

Total: 46 Hours

Reference(s)

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
2. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Learning. Ltd., New Delhi, 2011
3. L. A. Geddes and Baker, L.E., Principles of Applied Bio-medical Instrumentation, John Wiley and Sons Publishing Company, New York, 1995
4. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2000.
5. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003

22MC026 VIRTUAL INSTRUMENTATION AND APPLICATIONS 3 0 0 3

Course Objectives

- To understand the fundamentals of virtual instrumentation, and basic concept of Graphical programming with their functions in LabVIEW.
- To know the various types Interfaces and Protocol used in VI
- To describe the components of typical DAQ and various tools in VI with their application

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Find the fundamentals of virtual Instrumentation and compare conventional with traditional methods
2. Predict the concept of graphical programming and LabVIEW with their functions
3. Assess the types of interfacing devices and protocol used in VI
4. Select the functions and the interface requirements in Data acquisition system
5. Outline the types of VI tools with its application

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

UNIT I **9 Hours**

INTRODUCTION TO VI

Historical perspective and Traditional bench-top instruments General functional description of a digital instrument Block diagram of a Virtual Instrument Physical quantities and analog interfaces Hardware and Software Advantages of Virtual Instruments over conventional instruments Architecture of a Virtual Instrument and its relation to the operating system

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING

Concepts of graphical programming LabVIEW software Concept of VIs and sub VI Error Handling Techniques Display types Digital Analog Chart and Graphs. Timers and dialog controls Loops structures Arrays Clusters. Local and global variables String and file I/O. State Machine Architecture Design pattern Producer Consumer pattern Master Slave pattern

UNIT III **9 Hours**

INSTRUMENT INTERFACES AND PROTOCOLS

RS232, RS422, RS485 and USB standards IEEE 488 standard Introduction to bus protocols of MOD bus and CAN bus. Electronic standards for signals noise and EMI effects. Signal conditioning chassis and extension modules. Image acquisition cards and Motion Controllers

UNIT IV **9 Hours**

DATA ACQUISITION SYSTEM

Introduction to data acquisition on PC, Sampling fundamentals. Concepts of Data Acquisition and terminology Installing Hardware and drivers Configuring and addressing the hardware Digital and Analog I/O function Real time Data Acquisition USB based DAQ. Common Instrument Interfaces Current loop RS 232C RS485 and Bus Interfaces.

UNIT V **9 Hours**

VI TOOLS

Mathematical tools for statistical calculation Signal processing tools Fourier transforms, power spectrum Windowing and filtering tools -Control system tools PID controller Applications. CRO function generator Illustration and case study Temperature controller.

Total: 45 Hours

Reference(s)

1. Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3rd Edition), Prentice Hall, 2012
2. Sanjeev Gupta, Virtual Instrumentation using LabVIEW, TMH, 2013
3. Gary W. Johnson, Richard Jennings, Lab-view Graphical Programming, McGraw Hill Professional Publishing, 2011
4. Robert H. Bishop, Learning with Lab-view, Prentice Hall, 2013
5. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2010
6. https://nptel.ac.in/courses/108105062/10

22MC027 INDUSTRIAL DRIVES AND CONTROL 3 0 0 3

Course Objectives

- To understand the working principle and performance characteristics of 3-Phase Induction motor
- To determine the operation, characteristics and performance parameters of converters
- To describe feedback control and basic components of control drive system

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the various types of drive system with gear arrangement
2. Assess the construction and working principle of asynchronous and asynchronous machine
3. Use the operation and characteristics of invertors and its related techniques
4. Compare on various types of frequency pattern and control modes
5. Justify the integrate positioning programming for various types of application

Articulation Matrix

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

UNIT I **8 Hours**

BASICS OF DRIVE SYSTEM AND GEARS

Drive system introduction, Comparison of drives Characteristic curves, Gears introduction, Gears sizes and Gear ratio, various types.

UNIT II **10 Hours**

BASICS OF ASYNCHRONOUS

Design and theory of operation Motor, poles Construction Enclosure Torque Vs Speed characteristics curve,

Brakes Brake rectifiers, Encoder theory of operation, various types.

UNIT III **10 Hours**

TERNS BASICS OF FREQUENCY INVERTERS

Block diagram Components of inverter Brake chopper 4 quadrant operation accessories of invertors Energy recovery, Electromagnetic compatibility (EMC) affects, short Radio Frequency (RF) device, various communication types

UNIT IV **9 Hours**

FREQUENCY PATTERNS

Introduction to the voltage/ frequency (V/F) characteristic curve- 50 Hz pattern, 70 Hz pattern, 87 Hz pattern Open loop control modes variable frequency drive (VFC) closed loop control modes, introduction to field oriented control (FOC).

UNIT V **8 Hours**

IPOS PROGRAMMING, PARAMETER SET

Basics of IPOS programming commands, Sample programs, Touch probe, Compiler specific information, Various parameter sets, Various fault codes & its description

Total: 45 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2013
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2010
3. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2010
4. J.Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2017
5. SEW Study materials, practical workbooks

22MC028 CONTROL SYSTEM AND DRIVES FOR ELECTRIC VEHICLES 3 0 0 3

Course Objectives

- To impart knowledge in electric vehicles.
- To understand the control system of electric vehicles

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Assess working of Electric Vehicles and recent trends
2. Predict the properties of batteries and its types
3. Find electric drives unitits control for application of electric vehicles.
4. Outline the control of the electric vehicle design system.
5. Compare different power converter topology used for electric vehicle application

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	2	2	2	2	-	2	3
2	1	2	3	2	-	-	-	1	1	-	1	2	-	2
3	1	3	3	-	-	1	-	-	1	-	-	2	-	3
4	1	2	3	1	1	-	1	-	-	1	-	1	-	2
5	1	2	1	2	-	2	-	-	-	-	2	-	-	3
6	-	-	-	-	2	-	-	-	-	2	-	-	-	-

UNIT I **9 Hours**

ELECTRIC VEHICLES

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Electric Drive Trains, Architecture of Electric Drive Trains.

UNIT II **9 Hours**

ENERGY STORAGE FOR EV

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basicvprinciple and operation, Types of Fuel Cells, proton exchange membrane fuel cell (PEMFC) and its operation, Modelling of PEMFC, Super Capacitors

UNIT III **9 Hours**

ELECTRIC DRIVES

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives

UNIT IV **9 Hours**

DESIGN OF ELECTRIC VEHICLES

Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of battery, design of electric motor drive capacity, transmission design, energy storage design.

UNIT V **9 Hours**

POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Zconverter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology

Total: 45 Hours

Reference(s)

1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2015
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in HybridElectric Vehicles, Springer, 2018
3. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORDUniversity Press, 20161.
4. Chris Mi, M. AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2018

22MC029 PROCESS CONTROL 3 0 0 3

Course Objectives

- To obtain the mathematical models for first order and higher order real-time systems and also understand the concept of self-regulation
- To get adequate knowledge about the characteristics of various controller modes and controller tuning methods
- To understand how to apply the control schemes for various applications

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the mathematical models for first order real time systems.
2. Select the characteristics of various control modes and the concept of various control schemes.
3. Find the various controller tuning methods to tune the controller
4. Outline the construction, characteristics and applications of different type of actuators
5. Justify the process control knowledge on Industrial environment

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to Process Control and Automation Elements of Feedback Control Introduction to Process Modeling-Stability and Performance Analysis Open loop Stability and Performance Analysis: Closed loop

UNIT II **9 Hours**

CONTROLLER CHARACTERISTICS

Basic control actions characteristics of On-Off, proportional, integral , derivative control modes and composite control modes: P+I, P+D and P+I+D control modes - selection of control mode for different processes - typical control schemes for level, flow, pressure and temperature processes.

UNIT III **9 Hours**

TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL

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

UNIT IV **9 Hours**

FINAL CONTROL ELEMENT

Pneumatic and electric actuators valve positioner control valve, characteristics of control valves- type of valves: globe, butterfly, diaphragm, ball valves control valve sizing cavitation and flashing in control valves. Response of control valves, electric and electro pneumatic valves. Selection of control valves

UNIT V **9 Hours**

SELECTED UNIT OPERATIONS

Case study: control of CSTR, control of heat exchanger, Steam boiler: drum level control and combustion control. Distillation column control of top and bottom product compositions reflux ratio

Total: 45 Hours

Reference(s)

1. George Stephanopoulos, Chemical Process Control, Prentice Hall of India learning Pvt. Ltd., New Delhi, 2012
2. B. Wayne Bequette, Process Control: modeling, design, and simulation, Prentice Hall of India Learning Pvt.Ltd., New Delhi, 2008
3. Donald P. Eckman, Automatic Process Control, Wiley-India Pvt. Ltd., New Delhi, 200
4. Dale E. Seborg, D. A. Mellichamp and Thomas F Edgar, Process Dynamics and Control, Wiley-India, 2010
5. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008
6. Hill PublishingCo. Ltd., New Delhi, 2008

22MC030 ADVANCED INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To understand the various automation hardware for the given application.
- To review various control aspects of automation
- To obtain knowledge about capability of Industrial Automation

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO11. 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.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Analyze automation principles, strategies, and transfer mechanisms to determine suitable automation solutions for industrial applications.
2. Evaluate material handling and identification technologies to optimize efficiency in manufacturing and logistics.
3. Assess automated manufacturing systems, including GT, FMS, and cellular manufacturing, for improved production planning and implementation.
4. Apply industrial control technologies to develop automation strategies for discrete and process industries.
5. Construct mathematical models and simulations for plant automation using modern tools, with applications in cement, thermal, water treatment, and steel industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Automation in Production System - Principles and Strategies of Automation - Basic Elements of an Automated System - Advanced Automation Functions - Levels of Automations - Flow lines & Transfer Mechanisms - Fundamentals of Transfer Lines.

UNIT II **9 Hours**

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Overview of Material Handling Systems - Principles and Design Consideration - Material Transport Systems - Storage Systems Overview of Automatic Identification Methods.

UNIT III **10 Hours**

AUTOMATED MANUFACTURING SYSTEMS

Components - Classification and Overview of Manufacturing Systems - Manufacturing Cells - GT and Cellular Manufacturing FMS - FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods - SPC Tools - Inspection Principles and Practices - Inspection Technologies.

UNIT IV **9 Hours**

CONTROL TECHNOLOGIES IN AUTOMATION

Industrial Control Systems - Process Industries Versus Discrete-Manufacturing Industries - Continuous Versus Discrete Control - Computer Process and its Forms

UNIT V **8 Hours**

MODELING AND SIMULATION FOR PLANT AUTOMATION

Introduction - need for system Modeling - Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement Thermal Water Treatment & Steel Plants. SLE: Cases Studies minimum one for Cement - Thermal - Water Treatment & Steel Plants applications

Total: 45 Hours

Reference(s)

1. Krishna Kant, Computer Based Industrial Control, PHI, 2nd edition, 2011
2. M.P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education.5th edition, 2009.
3. Tiess Chiu Chang Richard A. Wysk, An Introduction to Automated Process Planning Systems, Longman Higher Education, 2015
4. Viswanandham, Performance Modeling of Automated Manufacturing Systems, PHI, 1st edition, 2009.

22MC031 IoT PROTOCOLS AND INDUSTRIAL SENSORS 3 0 0 3

Course Objectives

- To obtain the mathematical models for mathematical models for IoT networks and protocols
- To get adequate knowledge about the various Sensors, Actuators, and Smart Objects to Communicate Protocols.
- To understand how to apply the protocols for IoT networks and applications.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the mathematical models for IoT networks.
2. Assess the Standardized Architecture of various IoT and analyze the control applications
3. Find the various Sensors, Actuators, and Smart Objects to Communicate Protocols for WSN,RFID ,NFC.
4. Outline the connection of smart objects using Range, Frequency Bands , Power Consumption
5. Compare the protocols for IoT networks and applications

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO IOT

Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Basics of networking Communication protocol, wireless sensor networks.

UNIT II **9 Hours**

IOT NETWORK ARCHITECTURE AND DESIGN

The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model,Additional IoT Reference Models, A Simplified IoT Architecture, The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data Versus Network Analytics Data Analytics Versus Business Benefits , Smart Services.

UNIT III **9 Hours**

SMART OBJECTS IOT

Sensors, Actuators, and Smart Objects , Micro-Electro-Mechanical Systems (MEMS) Smart Objects: Trends in Smart Objects, Sensor Networks , Wireless Sensor Networks (WSNs) , Communication Protocols for WSN,RFID ,NFC.

UNIT IV **9 Hours**

CONNECTING SMART OBJECTS

Communications Criteria : Range , Frequency Bands , Power Consumption , Topology , Constrained Devices , Constrained-Node Networks , Data Rate and Throughput , Latency and Determinism , Overhead and Payload, IoT Access Technologies : Standardization and Alliances , Physical Layer , MAC Layer , Topology.

UNIT V **9 Hours**

IOT NETWORK LAYER AND APPLICATION PROTOCOLS

The Business Case for IP , The Key Advantages of Internet Protocol ,Adoption or Adaptation of the Internet Protocol ,The Need for Optimization ,Constrained Nodes , Constrained Networks IP Versions , Optimizing IP for IoT ,From 6LoWPAN to 6Lo, Header Compression, Fragmentation , Mesh Addressing ,Mesh-Under Versus Mesh-Over Routing.

Total: 45 Hours

Reference(s)

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC Press.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, Hands on Artificial intelligence for IoT, 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm, Springer.
6. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/

22MC032 INDUSTRIAL PROCESSORS 3 0 0 3

Course Objectives

- To understand the IoT concepts and standards
- To use various components of IoT system
- To analyze the challenges in IoT implementation
- To relate and apply IoT for the applications

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.
PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the need for interoperability in internet of things to solve the current challenges
2. Assess IOT systems with Arduino processor for programming and interfacing libraries.
3. Find Arduino programming to interface IOT systems with sensors and actuators.
4. Justify IOT systems interfaced with Raspberry Pi processor.
5. Integrate Python programming for real time applications connected with IOT systems.

Articulation Matrix

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

UNIT I **9 Hours**

IOT CONCEPTS

IoT Technologies that led to evolution of IoT IoT and SCADA IoT and M2M IoT and Big Data International standard Operating platforms Communication protocols Modbus Profibus RS485 RTU Ethernet

UNIT II **9 Hours**

COMPONENTS OF IOT SYSTEM

Design of IoT systems Device configuration and addressing Interfacing IoT sensors and actuators IoT cloud building blocks Platform specific dashboard MQTT Server Time series database Data monitoring, visualization and IoT analytics.

UNIT III **9 Hours**

SECURITY IN IOT

MQTT vs HTTP performance Security considerations Firmware updates Cryptography basics Cryptography in IoT Privacy considerations and design guidelines - Individual privacy.

UNIT IV **9 Hours**

IOT CASE STUDY

Lighting as a service Intelligent traffic systems Smart parking smart water management smart cities IoT for health services IoT for OEE evaluation IoT for Smart Factory and Smart Home Automation

UNIT V **9 Hours**

CHALLENGES IN IOT IMPLEMENTATION

Big data management -Connectivity challenges - Dashboard development challenges privacy implementation - Mission critical applications.

Total: 45 Hours

Reference(s)

1. Michael Miller, The Internet of Things: How Smart TVs, Smart Cars, Smart Homes,and Smart Cities Are Changing the World, QUE , 26 March 2015
2. Arsheep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Orient Blackswan Private Limited - New Delhi; First edition, 2015
3. Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., Internet of Things, Cengage Learning India Pvt. Ltd., 2018.
4. Adrian Mcewen, Hakin Cassimally, Designing The Internet of Things, Wiley, 2015

22MC033 IoT PROCESSORS 3 0 0 3

Course Objectives

- To understand the concepts of IoT and its working models with different processors
- To interface various IoT Physical devices and Endpoints with processors
- To get adequate knowledge about the programming and interfacing the real world systems

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

Course Outcomes (COs)

1. Select the main concepts, key technologies, strength and limitations of IoT.
2. Assess the architecture, infrastructure models of IoT.
3. Predict the networking and how the sensors are communicated in IoT .
4. Compare and design different models for IoT implementation.
5. Outline and design the new models for market strategic interaction

Articulation Matrix

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

UNIT I **6 Hours**

INTEROPERABILITY IN INTERNET OF THINGS

Interoperability Definition, Need, Types User & Device Syntactic Interoperability,Semantic Interoperability Ontology, Collaborative conceptualization theory, Universal Middleware Bridge Current challenges in IOT.

UNIT II **10 Hours**

DESIGN AND DEVELOPMENT OF IOT SYSTEMS WITH ARDUINO

Introduction to Arduino Features and Types Arduino IDE, Datatype, Function Libraries, Arduino Toolchain Arduino Programming Structure Sketches Pins Input Output From Pins Using Sketches Introduction to Arduino Shields, Operators, Control statement, Loops, Arrays, String, Math Library, Random Number, Interrupts, Programming exercises.

UNIT III **9 Hours**

INTEGRATION OF SENSORS AND ACTUATORS WITH ARDUINO

Sensors, Types Temperature, Humidity, Compass, Light, Sound, Accelerometer, and Sensor interface with Arduino. Actuators introduction, Types of motor actuators Servo, Stepper, Solenoid, Relay, AC motor Stepper and Servo Motor interfaced with Arduino Programming exercises

UNIT IV **10 Hours**

BUILDING IOT WITH RASPBERRY PI

Raspberry Pi Specifications, Architecture, GPIO, Pin configuration, Operating system setup, Capture image using Raspberry Pi Implementation of Raspberry Pi with IoT Systems Creating an interactive environment using sensor and actuator, Remote data logging.

UNIT V **10 Hours**

PYTHON PROGRAMMING FOR IOT SYSTEMS

Introduction, Need for Python programming, Python IDE, Data types, Control statements, Functions, Variables, Modules, Exception Handling Logical Design using Python File Read Write and Image Read Write operations, Networking in Python, Interfacing with IoT Raspberry Pi Real time applications.

Total: 45 Hours

Reference(s)

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press. Donald P. Eckman, Automatic Process Control, Wiley-India Pvt. Ltd., New Delhi,
3. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer.
5. Peter Friess,Internet of Things From Research and Innovation to Market Deployment, River Publishers.
6. https://onlinecourses.nptel.ac.in/noc22_cs96/course

22MC034 IoT SYSTEM DESIGN 3 0 0 3

Course Objectives

- To understand the basics of IoT.
- To get knowledge about the various services provided by IoT.
- To familiarize themselves with various communication techniques and networking.
- To know the implementation of IoT with different tools.
- To understand the various applications in IoT.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Articulate the main concepts, key technologies, strength and limitations of IoT.
2. Identify the architecture, infrastructure models of IoT.
3. Analyze the networking and how the sensors are communicated in IoT .
4. Analyze and design different models for IoT implemention.
5. Identify and design the new models for market strategic interaction

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO INTERNET OF THINGS

Rise of the machines Evolution of IoT Web 3.0 view of IoT Definition and characteristics of IoT IoT Enabling Technologies IoT Architecture Fog, Edge and Cloud in IoT Functional blocks of an IoT ecosystem Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates A panaromic view of IoT applications.

UNIT II **9 Hours**

MIDDLEWARE AND PROTOCOLS OF IOT

Middleware technologies for IoT system IoT Ecosystem Overview Horizontal Architecture Approach for IoT Systems SOA based IoT Middleware) Middleware architecture of RFID,WSN,SCADA,M2M Interoperability challenges of IoT Protocols for RFID,WSN,SCADA,M2M- Zigbee, KNX, BACNet, MODBUS Challenges Introduced by 5G in IoT Middleware Technological Requirements of 5G Systems Perspectives and a Middleware Approach Toward 5G COMPaaS Middleware Resource management in IoT.

UNIT III **9 Hours**

COMMUNICATION AND NETWORKING

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4,802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN Network Layer: IP versions, Constrained Nodes and Constrained Networks Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks Application Transport Methods: Supervisory Control and Data Acquisition Application Layer Protocols: CoAP and MQTT Data aggregation & dissemination.

UNIT IV **9 Hours**

IOT IMPLEMENTATION TOOLS

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python, Implementation of IoT with Raspberry Pi.

UNIT V **9 Hours**

APPLICATIONS AND CASE STUDIES

Home automations Smart cities Environment Energy Retail Logistics Agriculture Industry Health and life style Case study.

Total: 45 Hours

Reference(s)

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.
2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, Internet of Things (IoT) in 5G Mobile Technologies Springer International Publishing Switzerland 2016.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things Springer-Verlag Berlin Heidelberg, 2011.

22MC035 WIRELESS SENSOR NETWORK DESIGN 3 0 0 3

Course Objectives

- To obtain a broad understanding of various challenges involved to design wireless sensor networks
- To understand the recent technologies and applications of wireless sensor networks

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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

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: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Predict the fundamentals of wireless sensor networks and its applications in enabling technologies.
2. Assess the architecture of wireless sensor network and its execution environment
3. Find the MAC and routing protocols for wireless sensor networks and also the assignment of MAC Addresses.
4. Compare wireless sensor networks with the role of topology control, synchronisation and localization for various applications
5. Justify the tools and platforms needed to establish sensor networks and its applications

Articulation Matrix

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

UNIT I **9 Hours**

OVERVIEW OF WIRELESS SENSOR NETWORKS

Key definitions of sensor networks, Challenges for Wireless Sensor Networks Characteristics requirements required mechanisms, Difference between mobile ad-hoc and sensor networks, Advantages of sensor Networks, Applications of sensor networks- Enabling Technologies for Wireless Sensor Networks

UNIT II **9 Hours**

ARCHITECTURES

Single-Node Architecture Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, WSN Network architecture: typical network architectures data relaying and aggregation strategies Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts

UNIT III **9 Hours**

NETWORKING OF SENSORS

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Issues in Designing a MAC protocol for wireless sensor network, Address and Name Management, Assignment of MAC Addresses, Routing Protocols Energy Efficient Routing, Geographic Routing.

UNIT IV **9 Hours**

INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering, Time Synchronisation, Localization and positioning- properties- approaches Single Hop localization, localization services, Sensor Tasking and Control

UNIT V **9 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS

Sensor Node Hardware Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State centric programming, Applications Of WSN: WSN Applications Home Control Building Automation Industrial Automation Medical Applications Reconfigurable Sensor Networks Highway Monitoring Military Applications. **Total: 45 Hour**

Reference(s)

1. Wireless Sensor Networks: Design, Deployment and Applications. United Kingdom, IntechOpen, 2021
2. Yang, Shuang-Hua. Wireless Sensor Networks: Principles, Design and Applications. United Kingdom, Springer London, 2013.
3. Holger Karl, Andreas Willig, Protocols And Architectures for Wireless Sensor Networks, John Wiley, 2005
4. Feng Zhao, Leonidas J, J Guibas, Wireless Sensor Networks An Information Processing Approach, Elsevier, 2007
5. Kazem Sohraby, Daniel Minoli, Taieb Znati, Wireless Sensor Networks-Technology, Protocols, And Applications, John Wiley, 2007.
6. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003

22MC036 DATA ANALYTICS FOR IoT 3 0 0 3

Course Objectives

- Understand the challenges of IOT analytics systems development and deployment
- To learn about data analytics and use cloud offerings related to IOT
- Ability to understand the Searching and security requirements of IOT
- Acquire the knowledge of Tools, Platform and Services for IOT Analytics
- To Develop IOT infrastructure for real time scenario

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

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.

PO5. 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.

PO6. 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.

PO7. 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.

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

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

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problems.

Course Outcomes (COs)

1. Assess the networking protocols for connecting devices and challenges of IOT Analytics
2. Predict the cloud based IOT and IOT in Data Analytics.
3. Use the concepts of Security requirements and Searching the IOT
4. Outline the different tools and services for IOT Analytics platform.
5. Compare applications of IOT Analytics 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	3	3	2	2	2	2	-	2	-	2	3
2	3	2	2	2	3	2	2	-	2	-	-	-	2	3
3	3	1	3	3	3	2	2	-	2	-	-	-	3	2
4	2	2	2	2	3	2	2	-	2	-	-	-	2	3
5	3	1	2	2	3	2	2	-	2	-	-	-	2	3

UNIT I **9 Hours**

INTRODUCTION TO IOT ANALYTICS

Introduction IOT Data and Big Data Challenges of IOT Analytics Applications IOT Analytics Lifecycle and Techniques IOT Devices and Networking Protocols

UNIT II **9 Hours**

IOT CLOUD, WEB SERVICES AND DATA ANALYTICS

Cloud based IOT Platform Iaas,Paas and Saas paradigms Requirements of IOT in Big Data Analytics Platform Functional Architecture Web server. Web server for IOT Amazon Web services for IOT Data Analytics for IOT

UNIT III **9 Hours**

SEARCHING THE INTERNET THINGS AND IOT SECURITY

Introduction A search architecture for social and physical sensors Local Event Retrieval Sensor Metadata Venue Recommendation Security Requirements in IOT Security Concerns in IOT Applications Security Architecture in the Internet of Things Insufficient Authentication/Authorization Insecure Access Control Threats to Access Control, Privacy, and Availability Attacks Specific to IOT

UNIT IV **9 Hours**

TOOLS AND SERVICE FOR IOT ANALYTICS

ital Architecture for IOT Analytics Applications Nodes Development Examples Open source framework for IOT Analytics as a service Introduction Architecture Sensing as a service Infrastructure Anatomy Scheduling, Metering and service delivery Sensing as a Service Example Semantic Analytics Tools and Platforms

UNIT V **9 Hours**

IOT ANALYTICS APPLICATIONS AND CASE STUDIES

Data Analytics and smart Building-Smart Cities-Data collection to deployment and operationalization using the vital platform Ethical IOT

Total: 45 Hours

Reference(s)

1. Wireless John Soldatos, Building Blocks for IOT Analytics, River Publisher 2017
2. Andrew Minteer, Analytics for the Internet of Things, Packet Publishing Pvt. Ltd., Birmingham, 2017.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014. Christopher M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
4. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012.
5. Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van,2018

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

Course Outcomes (COs)

1. Classify and characterize the various energy utilization techniques.
2. Identify suitable technique to provide an energy efficient system.
3. Identify the need for thermal systems with latest technologies.
4. Choose suitable techniques doe conserving energy with respect to emerging trends.
5. Assess the impact economics on the conservation of energy.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II **9 Hours**

ELECTRICAL SYSTEMS

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III **9 Hours**

THERMAL SYSTEMS

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and Encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV **9 Hours**

ENERGY CONSERVATION IN MAJOR UTILITIES

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V **9 Hours**

ECONIMICS

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept .

Total: 45 Hours

Reference(s)

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
5. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. 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.

PO5. 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.

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 **8 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 **8 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
POLYMORPHISM AND FILE STREAMS **10 Hours**
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 **10 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.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.

PO5. 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.

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
GUI WITH JAVA **9 Hours**

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.

22OCS03 KNOWLEDGE DISCOVERY IN DATABASES 3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.

Course Outcomes (COs)

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

Articulation Matrix

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

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS- Metadata- Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **8 Hours**
INTRODUCTION TO DATA MINING

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**
ASSOCIATION RULE MINING

Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**
CLASSIFICATION AND CLUSTERING

Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k-medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**
DATA MINING APPLICATIONS

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining - Application and trends in data mining - Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw-Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.

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 acqu isition 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.

22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS 3 0 0 3

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.

Course Outcomes (COs)

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

Articulation Matrix

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

UNIT I **7 Hours**
TEXT MINING
Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II METHODS **9 Hours**

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III
WEB ANALYTICS

9 Hours

Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval- Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**
SOCIAL NETWORK ANALYTICS

Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS

Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OEC01 BASICS OF ANALOG AND DIGITAL ELECTRONICS 3 0 0 3

Course Objectives

- Understand the working of diodes and transistors in electronic circuits.
- Understand the analog operational amplifier and its applications.
- Understand the implementation of combinational and sequential circuits in digital systems.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.

Course Outcomes (COs)

1. Apply the diodes and transistors in regulators and amplifiers and analyze their characteristics.
2. Illustrate the working of analog IC with different configurations and its applications.
3. Simplification of Boolean expressions using K-map and implementation of combinational circuits.
4. Analyze the Flip flops and memory configurations in digital circuits.
5. Classify and analyze A/D and D/A converters with its parameters.

Articulation Matrix

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

UNIT I **9 Hours**

SEMICONDUCTORS DEVICES

Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

UNIT II **9 Hours**

OPERATIONAL AMPLIFIERS: DC PERFORMANCE

The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

UNIT III **9 Hours**

DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS

Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws. Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

UNIT IV **9 Hours**

DIGITAL TECHNIQUES: SEQUENTIAL CIRCUITS

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

UNIT V **9 Hours**

DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS

DIGITAL TO ANALOG CONVERTERS : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches. ANALOG TO DIGITAL CONVERTERS: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

Total: 45 Hours

Reference(s)

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw- Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

22OEC02 MICROCONTROLLER PROGRAMMING 3 0 0 3

Course Objectives

- Understand Series of Microcontrollers in terms of architecture, Programming and Interfacing.
- Learn Programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers
- Learn the emerging trends in the design of advanced Microcontrollers.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO5. 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.

Course Outcomes (COs)

1. Interpret the components and functionalities of 8051 Microcontrollers.
2. Develop microprocessor applications using the Assembly Language Program
3. Illustrate the working nature of PIC microcontroller on various versions
4. Illustrate the interfacing of different peripherals using PIC Microcontroller
5. Analyze the architecture and instruction set of ARM Microcontroller

Articulation Matrix

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

UNIT I **9 Hours**

8-BIT MICROCONTROLLER

Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

UNIT II **9 Hours**

8051 ALP AND APPLICATIONS

Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

UNIT III **9 Hours**

PIC MICROCONTROLLER

PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

UNIT IV **9 Hours**

PIC HARDWARE

Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

UNIT V **9 Hours**

HIGH PERFORMANCE RISC ARCHITECTURE

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

FOR FURTHER READING

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers- Counters- Interrupts.

Total: 45 Hours

Reference(s)

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.
3. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.
4. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.
5. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

22OEC03 PRINCIPLES OF COMMUNICATION SYSTEMS 3 0 0 3

Course Objectives

- To study the various analog and digital modulation techniques
- To study the various digital communication techniques
- To enumerate the idea of spread spectrum modulation
- To study the design concepts of satellite and optical communication

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.

Course Outcomes (COs)

1. Illustrate the process involved in Amplitude, Frequency and phase modulation systems.
2. Analyze the performance of different digital modulation /demodulation techniques.
3. Analyze Pulse Code Modulation scheme for the transmission of analog data in digital format.
4. Apply the concepts of spread spectrum modulation techniques to eradicate interference in wireless communication.
5. Analyze the system design of satellite and optical communication.

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF ANALOG COMMUNICATION

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation. FM andPM waveforms, phase deviation and modulation index, frequency deviation and percent modulation,Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves

UNIT II **9 Hours**

DIGITAL COMMUNICATION

Introduction, Shannon limit for information capacity, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Minimum Shift Keying (MSK),Phase Shift Keying (PSK), BPSK, QPSK, 8 PSK Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency,Comparison of various Digital Communication System (ASK - FSK - PSK - QAM).

UNIT III **9 Hours**

DIGITAL TRANSMISSION

Introduction, Pulse modulation, PCM , PCM sampling, sampling rate, signal to quantization noise rate,companding, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission, Intersymbol interference, eye patterns.

UNIT IV **9 Hours**

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques, wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT V **9 Hours**

SATELLITE AND OPTICALCOMMUNICATION

Satellite Communication Systems-Keplers Law,LEO and GEO Orbits, footprint, Link model-OpticalCommunication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub,D L Schilling,G Saha ,Principles of Communication,3/e,2007.
4. B.P.Lathi,Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.

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

22OEI01 PROGRAMMABLE LOGIC CONTROLLERS 3 0 0 3

Course Objectives

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
PO5. 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.
PO7. 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.

Course Outcomes (COs)

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION TO AUTOMATION

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II **9 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

UNIT III **8 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV **10 Hours**

ADVANCED PLC FUNCTONS

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V **8 Hours**

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

22OEI02 SENSOR TECHNOLOGY 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO5. 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.

Course Outcomes (COs)

1. Conclude the static and dynamic characteristics of measuring instruments
2. Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors
3. Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor
4. Analyze and select the suitable sensor for different industrial applications
5. Combine the modern technologies and smart materials to design various sensors

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

UNIT I **8 Hours**

SENSORS FUNDAMENTALS AND CHARACTERISTICS

Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements - Measurands- Sensor Characteristics: Static and Dynamic.

UNIT II **8 Hours**

PHYSICAL PRINCIPLES OF SENSING

Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

UNIT III **9 Hours**

INTERFACE ELECTRONIC CIRCUITS

Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

UNIT IV **10 Hours**

SENSORS IN DIFFERENT APPLICATION AREA

Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

UNIT V **10 Hours**

SENSOR MATERIALS AND TECHNOLOGIES

Materials, Surface Processing- MEMS microsystem components- Microfluidics microsystem components - Nano Technology- Smart Materials.

Total: 45 Hours

Reference(s)

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, 2016.
2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, New Delhi, 2009.
3. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 1st Edition, World Scientific Publishing Co, Singapore, 2015.
4. Horowitz, P., and W. Hill. The Art of Electronics. 2nd ed. Cambridge University Press, 1989.

22OEI03 FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- Understand the basic components of Virtual Instrumentation system.
- Learn the developing VIs based on Lab VIEW software.
- To learn to develop applications based on Virtual Instrumentation system.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Outline the concepts of traditional instruments and virtual instruments
2. Conclude the overview of modular programming and the structuring concepts in VI programming
3. Attribute the procedure to install DAQ in various OS and its interfacing methods
4. Implement the VI toolsets for specific applications
5. Generate the applications using Virtual Instrumentation software

Articulation Matrix

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

UNIT II **9 Hours**

INTRODUCTION

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II **9 Hours**

VI PROGRAMMING TECHNIQUES

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III **9 Hours**

DATA ACQUISITION

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT IV **9 Hours**

VI TOOLSETS

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V **9 Hours**

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total: 45 Hours

Reference(s)

1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

22OEI04 OPTOELECTRONICS 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.

Course Outcomes (COs)

1. Attribute the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Conclude the fundamentals of laser, types of laser and its working.
4. Outline the applications of laser for industrial applications.
5. Differentiate the use of laser instruments for various medical applications.

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

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, 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. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

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
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 http://www.springer.com/978-1-4939-2112-6
6. 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
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) Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO5. 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.
PO6. 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.
PO7. 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.

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO5. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
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.**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
1	-	-	-	-	2	1	-	1	-	-	-	-
2	-	-	-	-	1	-	-	3	-	-	-	-
3	2	-	-	-	-	-	-	-	-	-	-	3
4	2	3	-	-	-	-	-	-	2	-	-	-
5	-	-	-	-	2	-	-	-	-	3	-	-

UNIT I **10 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 **10 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 **10 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 **8 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 spaces

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

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 ecofriendly options.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. 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.
PO7. 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.

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
1	1	-	2	-	-	-	3	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-
3	1	-	-	-	-	-	3	-	-	-	-	-	-
4	2	-	-	-	-	-	3	-	-	-	-	-	-
5	1	-	-	-	-	-	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 feed stocks, 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, Trans esterification: 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, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

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

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO8. Ethics: 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.

9 Hours

UNIT III

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

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: 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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
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.
PO7. 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.

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 OIL SEED TECHNOLOGY 3 0 0 3

Course Objectives

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
PO6. 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.

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	-	-	-	-	-	-	-	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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO7. 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.
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.

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
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.

UNIT IV **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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO5. 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.
PO6. 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.
PO8. Ethics: 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
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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO5. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: 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
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. Engineering Knowledge: 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 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 modeling 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	PO 6	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 nanotubes- 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

22OPH02 - SEMICONDUCTOR PHYSICS AND DEVICES 3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 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. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

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**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

UNIT II **9 Hours**

P-N JUNCTION

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor.

UNIT IV **9 Hours**

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM.

UNIT V **9 Hours**

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells – efficiency.

Total: 45 Hours

Reference(s)

1. Donald A Neamen, Semiconductor Physics and Devices, Tata McGraw Hill, 2012
2. S M Sze and M K Lee, Semiconductor Devices, Physics and Technology, John-Wiley & Sons, 2015
3. Ben G Streetman and S K Banerjee , Solid State Electronic Devices, Pearson Education Ltd, 2015
4. C Kittel, Introduction to Solid State Physics, John-Wiley & Sons, 2012
5. J Millman and C Halkias, Electronic Devices and Circuits, Tata McGraw Hill, 2010
6. Hagen Klauk, Organic Electronics: Materials, Manufacturing and Applications, Wiley-VCH, 2006

22OPH03 - APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)

PO1. Engineering Knowledge: 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 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.

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial 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	3	2	2	1	-	-	-	-	-	-	-	1	-	-
3	3	2	2	1	-	-	-	-	-	-	-	1	-	-
4	3	2	2	1	-	-	-	-	-	-	-	1	-	-
5	3	2	2	1	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator.

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO_2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement – holography.

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting- Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K Thiyagarajan and A K Ghatak, LASERS: Fundamentals and Applications, Springer, USA, 2015
2. M N Avadhanulu, An Introduction to Lasers Theory and Applications, S. Chand Publisher, 2013
3. W Koechner, M Bass, Solid State Lasers: a graduate text, Springer Verlag, New York, 2006
4. K P R Nair, Atoms, Molecules and Lasers, Narosa Publishing House, 2009
5. K R Nambiar, Lasers: Principles Types and Applications, New Age International Publications, 2006
6. A. Sennaroglu, Solid-State Lasers and Applications, CRC Press, 2006

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. Engineering Knowledge: 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 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	1	3	2	2	1	-	-	-	-	-	-	-	-	-
2	2	3	2	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	1	-	-	-	-	-	-	-	-	-
4	4	3	2	2	1	-	-	-	-	-	-	-	-	-
5	5	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 – TissueInteractionVariables - 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 intissues - Absorbing agents in tissues and blood - Skinoptics, response the UV radiation, Optical parameter soft issues - tissue welding - tissue contouring - tissuere generation - 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 - Invivo 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.

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, Wiley2007
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. Engineering Knowledge: 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 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 - visco elasticity. 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

References

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. 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.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.

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. Engineering Knowledge: 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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO7. 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.

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.

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. Engineering Knowledge: 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 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	PSO3
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. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones 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	PSO3
1	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-
2	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-
4	-	-	-	-	-	-	-	-	3	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-

UNIT I **9 Hours**

BASICS OF NTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF DEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, nalogies

UNIT III **9 Hours**

LEGAL ASPECTS OF USINESS

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.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, TataMcGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

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. 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.
PO7. 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.
PO9. Individual and Team Work: 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	PSO3
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, TataMcGraw-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. 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.
PO7. 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.
PO9. Individual and Team Work: 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	PSO3
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 LevelInstitutions-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)

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

c. 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.

g. 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.

l. 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.

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	PSO3
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.

9 Hours

UNIT II

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.

9 Hours

UNIT III

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

9 Hours

UNIT IV

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.

9 Hours

UNIT V

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

22MC0XA Embedded MODBUS Control for Industrial Drive Configuration

L	T	P	C
1	0	0	1

Pre-requisite

Basics of Electronics

Assessment Pattern

Mode: Continuous Internal Assessment (CIA) 100%

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

Use the MODBUS protocol for controlling and monitoring industrial drives, enabling them to design and implement efficient and reliable control systems in various industrial settings.

Programme Outcomes (POs)

PO1: Engineering Knowledge: 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/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.

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.

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

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problem.

Course Outcomes (COs)

1. Create and implement the MODBUS communication in embedded systems interfaces for monitoring and controlling industrial drives.
2. Modify the parameters of the MODBUS communication for establishing a reliable control system in industrial drives

Articulation Matrix

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

Introduction to Networks in Industrial Automations-Information flow requirements-network requirements- OSI reference model-IP Classes-Types of High speed ethernet cable-network topologies. EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface RS232/RS485 –Pinout Configurations using UNITY PRO – XL-PLC software – Configuring RS485 using Unity PRO -TCP/IP-Establishing device to device communications - Operation and Controls – Data writing and reading – MODBUS – VFD- Altivar – Schneider Electric – Commissioning – Parameters mapping – MODBUS registry address.

Total 15 Hours

References

1. Bela G. Liptak & Halit Eren, "Instrument Engineers Handbook: Process Software and Digital Networks ", 4th Edition, CRS Press, New York, 2011.
2. Mackay S., Wright E., Reynders D. & Park J., "Practical Industrial Data Networks: Design, Installation and Troubleshooting & quot;, Newnes Publication, Burlington, 2004.
3. Jonas Berge, "Modbus Buses for Process Control: Engineering, Operation, and Maintenance ", ISA Press, New York, 2004
4. Fundamentals of Industrial Drives – Sarkar B.V, 2012, PRENTICE HALL INDIA, ISBN : 9788120344334

Expert detail

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22MC0XB **Drone Design Techniques**

L	T	P	C
1	0	0	1

Pre-requisite **Basics of Electronics**

Mode: Continuous Internal Assessment (CIA) 100

Assessment Pattern

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

To develop a comprehensive understanding of the basics of drone design, assembly, calibration and flying To impart design skills required to design customized drones for specific applications

To train on the flight simulator software for drone flying training

Programme Outcomes (POs)

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/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.

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

PO7 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.

PSO1 Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2 Perform multidisciplinary activities in the mechatronics systems to solve real world problem.

Course Outcomes (COs)

The students will be able to

Analyze the concepts of drone design, assembly, calibration and flying Design

customized drones for specific applications

Use flight simulator software for drone flying training

Articulation Matrix

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

Intro to Drone Technology, Materials, Classification & Applications of Drones. UAVs in Current Scenario. Intro to Multicopters – Control flow chart – Payloads - How Quadcopter Fly - Pitch, Yaw and Roll. Components used in Drones – BLDC Motors, ESC, Flight Controller, Battery, Propeller, GPS, Accelerometer, Gyro Sensors, Transmitter and Receiver. Drone Flying- Frames – Quad Configurations - Assembly of Quadcopter – Components and Tools Used – Frame Assembly and Electronics Integration. Drone Flying Training – Intro to Flight Simulator - Control Sticks – Flight Maneuvers – Do's and Don'ts in Flying – Preflight Checks. Flight Controllers-Intro to Flight Controllers – Sensors used in Quadcopter – Gyroscope –Accelerometer – IMU - Thermal & Humidity Sensor – GPS. Battery –Charging & Discharging – Battery rating – Safety Precautions. Commercial Applications of Drones – Career and Entrepreneurial Opportunities. Flight Simulator-Calibrations – Intro to Mission Planner Software – Intro to Autonomous Flight Systems, DGCA Regulations for Drones – Safety Precautions and Maintenance.

Total 15 Hours

References

5. Reg Austin, "Unmanned Air Systems: UAV Design, Development and Deployment"First Edition, WileyPublishers, 2015.
6. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280- 316X. 34, 2002.
7. Droneprep, "Unmanned Aircraft Systems Logbook for Drone Pilots & Operators", Create Space Independent Publishing Platform, Latest Edition, 2015.

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22MC0XC **Engine and Vehicle Electronics Systems**

L	T	P	C
1	0	0	1

Pre-requisite

Automobile Engineering Basics of Electronics

Assessment Pattern

Mode: Continuous Internal Assessment (CIA) 100%

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

To develop a comprehensive understanding of the principles and concepts underlying engine and vehicle electronics systems, including their role in modern automotive technology.

To develop critical thinking and problem-solving skills by analyzing real-world engine and vehicle electronics issues and proposing effective solutions based on theoretical knowledge and practical experience.

To identify the key components and sensors used in engine and vehicle electronics systems, including their functions and interactions within the overall system.

Programme Outcomes (POs)

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/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.

PSO1: Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools.

PSO2: Perform multidisciplinary activities in the mechatronics systems to solve real world problem.

Course Outcomes (COs)

The students will be able to

1. Identify the different types of engine management strategies, including open-loop and closed-loop control
2. Apply onboard diagnostics (OBD) systems in monitoring and diagnosing engine and vehicle electronic faults
3. Evaluate the impact of engine electronics on vehicle performance, fuel efficiency, and emissions

Articulation Matrix

COs. No.	PO 1	PO 2	PO 3	PO 4	PO 5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PSO 1	PS O2
1	-	2	2	-	-	-	-	-	-	-	-	-	1	-
2	-	-	2	2	-	-	-	-	-	-	-	-	-	1

Air & Fuel solenoids in Electronic carburetors-Types of Solenoids. Solenoid Control Systems. Integration with Engine Management Systems. Engine Management Systems- Micro controller architectures in a two wheeler EMS system. Sensors and Actuators selection and characterization. Conventional air management system vs electronic throttle valve system. Control strategies to optimize engine and vehicle performance. Close loop operations. On board diagnosis system-Components. OBD-II Standards and Protocols. Common OBD-II Codes and Diagnostic Procedures. OBD-II Emissions Testing. Case Studies. Future Trends and Developments- Cyber security.

Total 15 Hours

References

1. Bosch Automotive Electrics and Automotive Electronics by Robert Bosch GmbH (2014, John Wiley & Sons)
2. Understanding Automotive Electronics by William B. Ribbens (2014, Cengage Learning)
3. Automotive Electrical and Electronic Systems by Tom Denton (2014, Routledge)

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22MC0XD Advanced LORAWAN-Enabled IoT Revolutionizing Smart Technology L T P C
1 0 0 1

Pre-requisite

Basic Knowledge of Microcontroller Basic Knowledge of C Programming

Assessment Pattern
Mode: Continuous Internal Assessment (CIA) 100%

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

To provide hands-on training to integrate the different sensors with the controller / wireless development board (wdm).

To provide hands-on training to communicate the data between controllers and servers using LORAWAN technology

Programme Outcomes (Pos)

PO1 Engineering knowledge: 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/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.

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.

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

PO6 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.

PS01 Design, analyze and develop automation solutions for complex problems in diverse sectors using modern tools

Course Outcomes (COs)

The students will be able to

1. To design embedded systems in IoT applications using various sensors and controllers.
2. To construct the uplink and downlink communication between the controller and network server.

Articulation Matrix

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

Introduction to ESP32- Hands-On: Integration LED with WDM -DIY: Integration LED with WDM - Hands- On: Integration IR Sensor, Flame sensor, DHT 11 Sensor, Ultrasonic sensor, Soil Moisture sensor with WDM- DIY - Hands-On: Controlling LED from BT Mobile App. – DIY - Hands-On: Sending constant data from End Device to Thingspeak channels - Hands-On: Sending Ultrasonic sensor data from End Device to Thingspeak channels.- DIY - Node to Node Communication with LoRa - Install LMIC Library for LoRaWAN Communication - Pin Mapping with Hardware - Uplink & Downlink from End Node to Network Server using OTAA Mode - Data Visualization in Application Server with Multiple widgets- Hands on demo: Ultrasonic sensor Data visualization in Application Server.

Total 15 Hours

References

1. Sudha Jamthe, IoT: How to Build Simple and Smart Solutions for Your Business ThroughInternet of Things, Createspace Independent Publishing Platform, Scotts Valley, CA, 2017
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Wiley, Hoboken, NJ, 2016
3. Olivier Hersent, David Delcourt, Laurent Dardé, LoRaWAN: The Definitive Guide, Wiley,Hoboken, NJ, 2019
4. Sravani Bhattacharjee, Shyam Sundar Ramasamy, Practical Industrial Internet of Things Security: A practitioner's guide to securing connected industries, Packt Publishing, Birmingham, UK, 2018

Expert detail

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22MC0XE	**Synergistic Partnerships: Integrating Humans and Robots in Industry 4.0**	L	T	P	C
		1	**0**	**0**	**1**

Pre-requisite: Basics of Industrial Automation

Assessment Pattern

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Mode: Continuous Internal Assessment (CIA) 100%

Course Objective

To educate the students on human-robot collaboration based tools using Industry 4.0 followed in the industry for various factory-automation based product development.

Programme Outcomes (POs)

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/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.

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 Collaborative Innovation: Understanding the importance of collaborative innovation ecosystems and partnerships in driving Industry 4.0 initiatives.

PSO2 Strategic Insights: Gain insights into how Industry 4.0 is reshaping business models, processes, and value chains, enabling them to develop strategic initiatives for their organizations.

Course Outcomes (COs)

The students will be able to

1. Identify factory-automation based problems
2. Provide solutions to industry 4.0 problems

Articulation Matrix*(Times New Roman,11 font size, Bold letters in Capitalize Each Word)*

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

SYNERGISTIC PARTNERSHIPS: INTEGRATING HUMANS AND ROBOTS IN INDUSTRY 4.0

Core idea of Industry 4.0 - Production system - Current state of human-robot collaboration - Technologies - How is India preparing for Industry 4.0 - Recent Technological Components of Robots - Advanced Sensor Technologies - Internet of Robotic Things - Cloud Robotics and Cognitive Architecture for Cyber Physical Robotics - Industrial Robotic Applications - Connecting Machines - M2M Communication - Connecting Devices - Roadmap for Deployment of I4.0 - Integration of ERP with I4.0 - Sensor interfacing and Data Migration - Moving Data to Cloud - Digitization in Logistics and Data Security - Data Analytics - Human Robot Collaboration at the learning factory (a remote view into the learning factory)

Hands-on : Human – Robot Interface, Task Allocation and Planning, Sensor Integration, Machine Learning for Collaboration.

Total 15 Hours

References

1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, Taylor and Francis, 2020
2. Miller M, The Internet of Things: How smart TVs, smart cars, smart homes, and smart cities are changing the world, Pearson Education, 2015, ISBN: 9780134021300
3. Pengwei Du and Ning Lu, Energy storage for smart grids: planning and operation for renewable and variable energy resources VERs, Academic Press, 2018, Reprint edition, ISBN-13:978-0128100714
4. Lihui Wang, Xi Vincent Wang, József Váncza, Zsolt Kemény, Advanced Human-Robot Collaboration in Manufacturing, Springer Nature Switzerland AG, 2021, First Edition, ISBN : 978-3-030-69177-6

Expert detail

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