B.E. (Electronics and Instrumentation Engineering)

Revised 2018 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

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VISION OF THE DEPARTMENT

To empower the graduates with first-class engineering skill and make them excel in the field of automation to serve the National and International needs both at social and industrial fronts with the help of centre of excellence in the core domain.

MISSION OF THE DEPARTMENT

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

PROGRAMME EDUCATIONAL OBJECTIVIES (PEOs)

I	Work in multidisciplinary engineering automation domain, allied industries, software companies and academic institution.
II	Pursue their higher studies/research at the reputed institution in India /abroad
III	Have the social responsibility, team work skill, leadership capabilities and lifelong learning in their professional field and also become entrepreneurs

PROGRAMME OUTCOMES (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. Design solutions for complex engineering problems and design system 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. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. 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. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and normsof the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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.

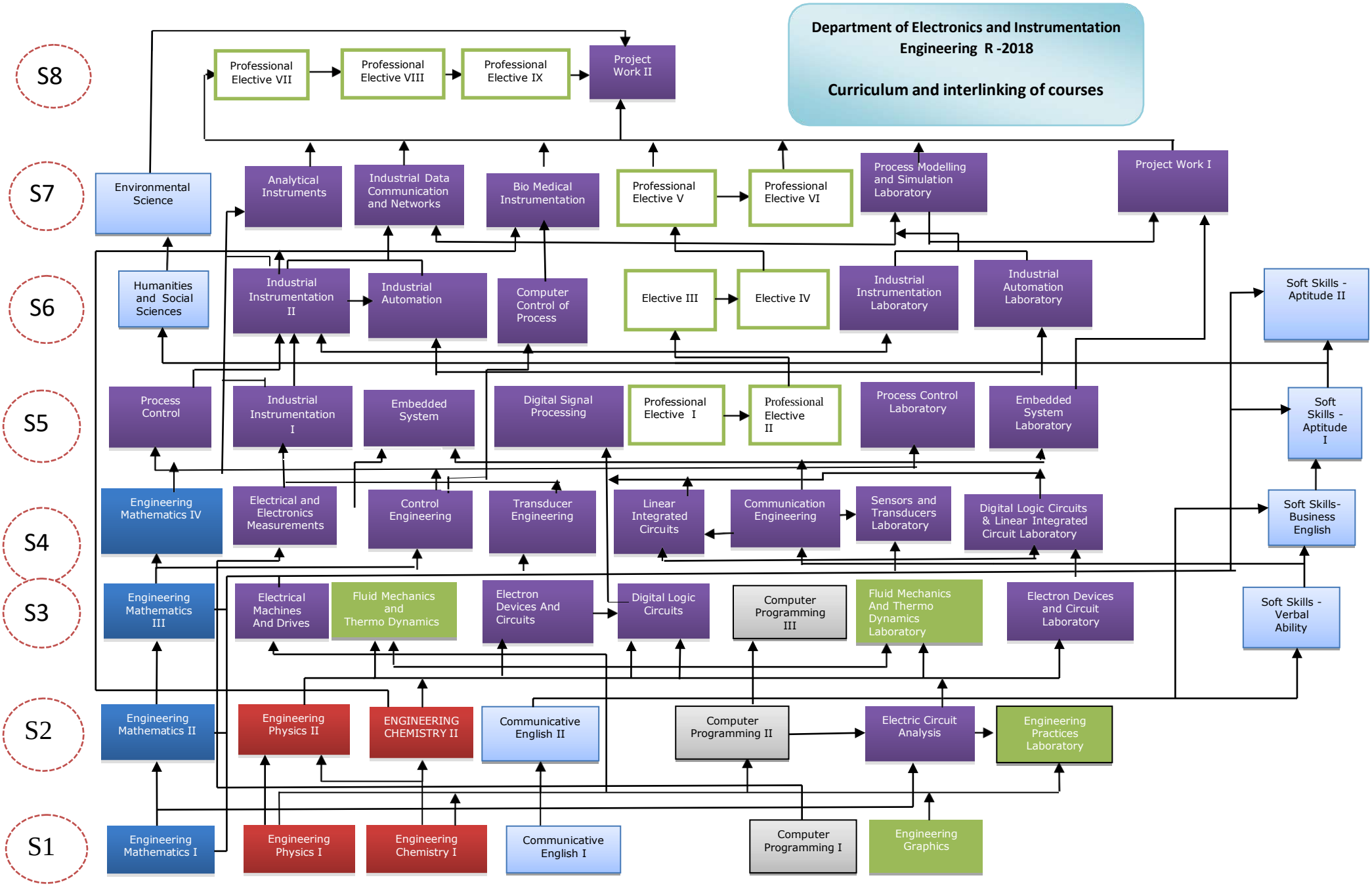
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

MAPPING OF PEOs AND POs

POs	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
I	X	X	X		X					X			X	X
II	X	X		X			X			X			X	X
III					X	X	X	X		X	X	X	X	X



General Electives (I to IX) are the courses offered by the department.

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING **Minimum Credits to be Earned: 161** **I SEMESTER**										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18EI101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
18EI102	ENGINEERING PHYSICS I	2	0	2	3	4	50	50	100	BS
18EI103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18EI104	COMPUTER PROGRAMMING I	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HS
18EI106	ENGINEERING GRAPHICS	1	0	4	3	5	100	0	100	ES
Total		**11**	**1**	**12**	**18**	**24**	**-**	**-**	**-**	**-**
II SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18EI201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
18EI202	ENGINEERING PHYSICS II	2	0	2	3	4	50	50	100	BS
18EI203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18EI204	ELECTRIC CIRCUIT ANALYSIS	3	1	0	4	4	40	60	100	ES
	LANGUAGE ELECTIVE	-	-	-	2	-	100	0	100	HS
18EI206	COMPUTER PROGRAMMING II	2	0	2	3	4	50	50	100	ES
18EI207	ENGINEERING PRACTICES LABORATORY	0	0	4	2	4	100	0	100	ES
Total		**12**	**2**	**10**	**21**	**24**	**-**	**-**	**-**	**-**

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18EI301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
18EI302	ELECTRICAL MACHINES AND DRIVES	2	0	2	3	4	50	50	100	ES
18EI303	FLUID MECHANICS AND THERMO DYNAMICS	3	1	0	4	4	40	60	100	ES
18EI304	ELECTRON DEVICES AND CIRCUITS	3	1	0	4	4	40	60	100	ES
18EI305	DIGITAL LOGIC CIRCUITS	3	1	0	4	4	40	60	100	PC
18EI306	COMPUTER PROGRAMMING III	2	0	2	3	4	50	50	100	ES
18EI307	ELECTRON DEVICES AND CIRCUITS LABORATORY	0	0	2	1	2	100	0	100	ES
18EI308	FLUID MECHANICS AND THERMO DYNAMICS LABORATORY	0	0	2	1	2	100	0	100	ES
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**16**	**4**	**10**	**24**	**30**	-	-	-	-
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18EI401	ENGINEERING MATHEMATICS IV	3	1	0	4	4	40	60	100	BS
18EI402	ELECTRICAL AND ELECTRONIC MEASUREMENTS	3	0	0	3	3	40	60	100	PC
18EI403	CONTROL ENGINEERING	3	0	2	4	5	50	50	100	PC
18EI404	TRANSDUCER ENGINEERING	3	0	0	3	3	40	60	100	PC
18EI405	LINEAR INTEGRATED CIRCUITS	3	1	0	4	4	40	60	100	PC
18EI406	COMMUNICATION ENGINEERING	3	0	2	4	5	50	50	100	PC
18EI407	DIGITAL LOGIC CIRCUITS & LINEAR INTEGRATED CIRCUITS LABORATORY	0	0	2	1	2	100	0	100	PC
18EI408	SENSORS AND TRANSDUCER LABORATORY	0	0	2	1	2	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HS
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**20**	**2**	**10**	**24**	**32**	-	-	-	-

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21EI501	PROCESS CONTROL	3	1	0	4	4	40	60	100	PC
21EI502	INDUSTRIAL INSTRUMENTATION –I	3	0	0	3	3	40	60	100	PC
21EI503	EMBEDDED SYSTEM	3	1	0	4	4	40	60	100	PC
21EI504	DIGITAL SIGNAL PROCESSING	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
21EI507	PROCESS CONTROL LABORATORY	0	0	2	1	2	100	0	100	PC
21EI508	EMBEDDED SYSTEM LABORATORY	0	0	2	1	2	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**18**	**3**	**6**	**23**	**27**	**-**	**-**	**-**	**-**
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21EI601	INDUSTRIAL AUTOMATION	3	1	0	4	4	40	60	100	PC
21EI602	INDUSTRIAL INSTRUMENTATION –II	3	0	0	3	3	40	60	100	PC
21EI603	INTERNET OF THINGS	3	0	0	3	3	40	60	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
21EI607	INDUSTRIAL INSTRUMENTATION LABORATORY	0	0	2	1	2	100	0	100	PC
21EI608	INDUSTRIAL AUTOMATION LABORATORY	0	0	2	1	2	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**6**	**21**	**25**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HS
21EI702	INDUSTRIAL DATA COMMUNICATION AND NETWORKS	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 XI	3	0	0	3	3	40	60	100	PE
21EI707	PROCESS MODELING AND SIMULATION LABORATORY	0	0	2	1	2	100	0	100	PC
21EI708	PROJECT WORK I	0	0	6	3	6	50	50	100	EEC
Total		**17**	**0**	**8**	**21**	**25**	**-**	**-**	**-**	**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21EI801	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
Total		**0**	**0**	**18**	**9**	**18**	**-**	**-**	**-**	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
PHYSICS ELECTIVES										
18GE0P1	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	BS
18GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	BS
18GE0P3	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	BS
CHEMISTRY ELECTIVES										
18GE0C1	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	BS
18GE0C2	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	BS
18GE0C3	POLYMER SCIENCE	3	0	0	3	3	40	60	100	BS
MATHEMATICS ELECTIVES										
18GE0M1	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	BS
18GE0M2	ALGEBRA AND NUMBER THEORY	3	0	0	3	3	40	60	100	BS
18GE0M3	MATHEMATICAL FINANCE AND QUEUEING THEORY	3	0	0	3	3	40	60	100	BS
ENTREPRENEURSHIP ELECTIVES										
18GE0E1	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	PE
18GE0E2	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	PE
ONE CREDIT COURSES										
18EI0XA	VIRTUAL INSTRUMENTATION IN INDUSTRIAL AUTOMATION	1	0	0	1	1	100	0	100	OC
18EI0XB	CALIBRATION TECHNIQUES	1	0	0	1	1	100	0	100	OC
18EI0XC	FACTORY AUTOMATION	1	0	0	1	1	100	0	100	OC
18EI0XD	INDUSTRIAL SAFETY STANDARDS FOR INSTRUMENTATION PRODUCTS	1	0	0	1	1	100	0	100	OC
18EI0XE	PIPING AND INSTRUMENTATION	1	0	0	1	1	100	0	100	OC
18EI0XF	VFD BASED INDUSTRIAL APPLICATIONS	1	0	0	1	1	100	0	100	OC
18EI0XG	SAFETY INSTRUMENT SYSTEM DESIGN	1	0	0	1	1	100	0	100	OC

ADDITIONAL ONE CREDIT COURSES										
18GE0XA	ETYMOLOGY	1	0	0	1	1	100	0	100	-
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-
18GE0XC	NEURO BEHAVIOURAL SCIENCE	1	0	0	1	1	100	0	100	-
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1	1	100	0	100	-
18GE0XE	YOGA FOR HUMAN EXCELLANCE	1	0	0	1	1	100	0	100	-
18GE0XF	VEDIC MATHEMATICS	1	0	0	1	1	100	0	100	-
18GE0XG	ABNORMAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-
18GE0XH	YOGA FOR ENERGETIC LIFE	1	0	0	1	1	100	0	100	-
18GE0XI	BLOG WRITING	1	0	0	1	1	100	0	100	-
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	1	1	100	0	100	-
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	1	1	100	0	100	-
18GE0XL	NATIONAL CADET CORPS	1	0	0	1	1	100	0	100	-
18GE0XM	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	1	100	0	100	-
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	1	100	0	100	-
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-
18GE0XP	FM RADIO BROADCASTING TECHNOLOGY	1	0	0	1	1	100	0	100	-
VALUE ADDED COURSES										
18EIV01	C PROGRAMMING FOR INSTRUMENTATION									

PROFESSIONAL ELECTIVES										
VERTICAL I - SENSOR TECHNOLOGIES AND IOT										
21EI001	SMART SENSORS	3	0	0	3	3	40	60	100	PE
21EI002	IOT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
21EI003	IOT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21EI004	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
21EI005	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
21EI006	DATA ANALYTICS FOR IOT	3	0	0	3	3	40	60	100	PE
VERTICAL II - AUTOMATION										
21EI007	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE
21EI008	BUILDING AUTOMATION	3	0	0	3	3	40	60	100	PE
21EI009	INTELLIGENT AUTOMATION	3	0	0	3	3	40	60	100	PE
21EI010	SMART MANUFACTURING	3	0	0	3	3	40	60	100	PE
21EI011	AI AND EXPERT SYSTEM FOR AUTOMATION	3	0	0	3	3	40	60	100	PE
21EI012	INTELLIGENT CONTROL	3	0	0	3	3	40	60	100	PE
VERTICAL III - APPLIED INSTRUMENTATION										
21EI013	ANALYTICAL INSTRUMENTS	3	0	0	3	3	40	60	100	PE
21EI014	VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21EI015	INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES	3	0	0	3	3	40	60	100	PE
21EI016	POWER PLANT INSTRUMENTATION AND CONTROL	3	0	0	3	3	40	60	100	PE
21EI017	FIBRE OPTICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21EI018	INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES	3	0	0	3	3	40	60	100	PE

VERTICAL IV - SEMICONDUCTOR / EMBEDDED										
21EI019	SEMICONDUCTOR MANUFACTURING	3	0	0	3	3	40	60	100	PE
21EI020	AUTOMOTIVE ELECTRONICS	3	0	0	3	3	40	60	100	PE
21EI021	GREEN ELECTRONICS	3	0	0	3	3	40	60	100	PE
21EI022	DIGITAL VLSI	3	0	0	3	3	40	60	100	PE
21EI023	REAL TIME EMBEDDED SYSTEMS	3	0	0	3	3	40	60	100	PE
21EI024	SOLAR PV FUNDAMENTAL AND APPLICATIONS	3	0	0	3	3	40	60	100	PE
VERTICAL V - ADVANCED CONTROL SYSTEMS										
21EI025	PROCESS MODELING AND SIMULATION	3	0	0	3	3	40	60	100	PE
21EI026	SYSTEM IDENTIFICATION	3	0	0	3	3	40	60	100	PE
21EI027	NON LINEAR CONTROL	3	0	0	3	3	40	60	100	PE
21EI028	ADAPTIVE CONTROL	3	0	0	3	3	40	60	100	PE
21EI029	DIGITAL CONTROL SYSTEM	3	0	0	3	3	40	60	100	PE
21EI030	OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING										
21EI031	APPLIED SOFT COMPUTING	3	0	0	3	3	40	60	100	PE
21EI032	MACHINE LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EI033	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EI034	PYTHON PROGRAMMING FOR AIAND ML	3	0	0	3	3	40	60	100	PE
21EI035	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EI036	NATURAL LANGUAGE PROCESSING	3	0	0	3	3	40	60	100	PE
VERTICAL VII - HEALTHCARE INSTRUMENTATION										
21EI037	BIOMEDICAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21EI038	DIGITAL IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
21EI039	BIO SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
21EI040	HUMAN ASSISTIVE DEVICES	3	0	0	3	3	40	60	100	PE
21EI041	MEDICAL IMAGING SYSTEMS	3	0	0	3	3	40	60	100	PE
21EI042	BRAIN COMPUTER INTERFACE	3	0	0	3	3	40	60	100	PE

HONOURS DEGREE (With Specialization)										
VERTICAL VII - HEALTHCARE INSTRUMENTATION										
21EIH01	BIOMEDICAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21EIH02	DIGITAL IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
21EIH03	BIO SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
21EIH04	HUMAN ASSISTIVE DEVICES	3	0	0	3	3	40	60	100	PE
21EIH05	MEDICAL IMAGING SYSTEMS	3	0	0	3	3	40	60	100	PE
21EIH06	BRAIN COMPUTER INTERFACE	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING										
21EIH07	APPLIED SOFT COMPUTING	3	0	0	3	3	40	60	100	PE
21EIH08	MACHINE LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EIH09	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EIH10	PYTHON PROGRAMMING FOR AI AND ML	3	0	0	3	3	40	60	100	PE
21EIH11	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
21EIH12	NATURAL LANGUAGE PROCESSING	3	0	0	3	3	40	60	100	PE
VERTICAL II - AUTOMATION										
21EIH13	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE
21EIH14	BUILDING AUTOMATION	3	0	0	3	3	40	60	100	PE
21EIH15	INTELLIGENT AUTOMATION	3	0	0	3	3	40	60	100	PE
21EIH16	SMART MANUFACTURING	3	0	0	3	3	40	60	100	PE
21EIH17	AI AND EXPERT SYSTEM FOR AUTOMATION	3	0	0	3	3	40	60	100	PE
21EIH18	INTELLIGENT CONTROL	3	0	0	3	3	40	60	100	PE

MINOR DEGREE (Other than EIE Students)										
VERTICAL I - SENSOR TECHNOLOGIES AND IOT										
21EIM01	SMART SENSORS	3	0	0	3	3	40	60	100	PE
21EIM02	IOT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
21EIM03	IOT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21EIM04	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
21EIM05	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
21EIM06	DATA ANALYTICS FOR IOT	3	0	0	3	3	40	60	100	PE

OPEN ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21OCE01	Energy Conservation and Management	3	0	0	3	3	40	60	100	OE
21OCS01	Object Oriented Programming	3	0	0	3	3	40	60	100	OE
21OCS02	JAVA Fundamentals	3	0	0	3	3	40	60	100	OE
21OCS03	Knowledge Discovery in Databases	3	0	0	3	3	40	60	100	OE
21OCS04	E-Learning Techniques	3	0	0	3	3	40	60	100	OE
21OCS05	Social Text and Media Analytics	3	0	0	3	3	40	60	100	OE
21OEC01	Basics of Analog and Digital Electronics	3	0	0	3	3	40	60	100	OE
21OEC02	Microcontroller Programming	3	0	0	3	3	40	60	100	OE
21OEC03	Principles of Communication Systems	3	0	0	3	3	40	60	100	OE
21OEC04	Principles of Computer Communication and Networks	3	0	0	3	3	40	60	100	OE
21OME01	Digital Manufacturing	3	0	0	3	3	40	60	100	OE
21OME02	Industrial Process Engineering	3	0	0	3	3	40	60	100	OE
21OME03	Maintenance Engineering	3	0	0	3	3	40	60	100	OE
21OME04	Safety Engineering	3	0	0	3	3	40	60	100	OE
21OBT01	Biofuels	3	0	0	3	3	40	60	100	OE
21OFD01	Traditional Foods	3	0	0	3	3	40	60	100	OE
21OFD02	Food Laws and Regulations	3	0	0	3	3	40	60	100	OE
21OFD03	Post-Harvest Technology of Fruits and Vegetables	3	0	0	3	3	40	60	100	OE
21OFD04	Cereal, Pulses and Oil Seed Technology	3	0	0	3	3	40	60	100	OE
21OFT01	Fashion Craftsmanship	3	0	0	3	3	40	60	100	OE
21OFT02	Interior Design in Fashion	3	0	0	3	3	40	60	100	OE
21OFT03	Surface Ornamentation	3	0	0	3	3	40	60	100	OE
21OPH01	Nanomaterials Science	3	0	0	3	3	40	60	100	OE
21OPH02	Semiconductor Physics and Devices	3	0	0	3	3	40	60	100	OE
21OPH03	Applied Laser Science	3	0	0	3	3	40	60	100	OE
21OPH04	Bio-photonics	3	0	0	3	3	40	60	100	OE
21OPH05	Physics of Soft Matter	3	0	0	3	3	40	60	100	OE

21OCH01	Corrosion Science and Engineering	3	0	0	3	3	40	60	100	OE
21OCH02	Polymer Science	3	0	0	3	3	40	60	100	OE
21OCH03	Energy Storing Devices	3	0	0	3	3	40	60	100	OE
21OMA01	Graph Theory and Combinatorics	3	0	0	3	3	40	60	100	OE
21OGE01	Principles of Management	3	0	0	3	3	40	60	100	OE
21OGE02	Entrepreneurship Development I	3	0	0	3	3	40	60	100	OE
21OGE03	Entrepreneurship Development II	3	0	0	3	3	40	60	100	OE
21OGE04	Nation building: Leadership and Social Responsibility	3	0	0	3	3	40	60	100	OE
21OAM01	Computer Vision in Healthcare Application	3	0	0	3	3	40	60	100	OE
21OAM02	Neural Networks	3	0	0	3	3	40	60	100	OE

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	4	4	0	0	0	0	28	16.47	15%	20%
2	ES	6	9	16	0	0	0	0	0	31	18.24	15%	20%
3	HSS	2	2	0	0	0	2	2	0	8	4.71	5%	10%
4	PC	0	0	4	20	17	13	10	0	64	37.65	30%	40%
5	PE	0	0	0	0	6	6	6	9	27	15.88	15%	20%
6	EEC	0	0	0	0	0	0	3	9	12	7.06	5%	10%
Total		18	21	24	24	23	21	21	18	170	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

18EI101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.

Course Outcomes (COs)

1. Represent the different forms of coordinate system in complex plane and characteristics of linear systems by Eigenvalues and Eigenvectors
2. Analyse various types of functions and their differentiation techniques involved in engineering fields.
3. Implement different methods of integration used in engineering problems.
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

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

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices: Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L-Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem

FURTHER READING

Quadratic forms -Reduction of a quadratic form to a canonical form - Application of conic sections, quadratic surfaces - discrete dynamical systems - Triple integral in polar coordinates-Formation of Bus Admittance Matrices. Applications of mass spring system in ordinary differential equations of higher order.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited,New Delhi 2015.
3. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995
5. Ayres F Jr and Mendelson E, Schaums Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.

18EI102 ENGINEERING PHYSICS I 2 0 2 3

Course Objectives

- Illustrate the Newtons laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

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

Course Outcomes (COs)

1. Illustrate the Newtons three laws of motion and apply the same to solve the real world problems involving elevator, atwood machine and acceleration of objects
2. Exemplify the physical characteristics of simple harmonic motion, wave motion and find the solutions for wave equations
3. Infer the fundamental laws, properties of electricity and magnetism and apply the same to electric and magnetic elements.
4. Apply the principles of physical and geometrical optics in the mirrors, lenses, microscopes and diffraction gratings
5. Outline the importance of special theory of relativity, quantum physics and analyse the wave and particle nature of matter

Articulation Matrix

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

UNIT I **6 Hours**

MECHANICS

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial frames - definition of mass - Newtons second law-gravitational force and weight; Newtons third law. Applications of Newtons laws: particle in equilibrium, particle under net force weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord

UNIT II **6 Hours**

OSCILLATIONS AND WAVES

Fundamentals of simple harmonic motion - energy of simple harmonic oscillator - spring mass system - time period of simple pendulum, compound pendulum and torsional pendulum - Damped oscillations. Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

UNIT III **6 Hours**

ELECTRICITY AND MAGNETISM

Point charges - electric fields - Gauss law and its applications - electric potential - capacitance - energy stored in a capacitor. Concept and source of magnetic fields - Amperes theorem - determination of magnetic field due to different current distributions - Faradays law - self-induction and mutual induction - energy stored in an inductor

UNIT IV **6 Hours**

LIGHT AND OPTICS

Nature of light - laws of reflection and refraction - refractive index and Snells law - dispersion of light - total internal reflection - image formation: concave mirrors - convex mirrors - thin lenses - compound microscope - human eye. Conditions of interference - Youngs double slit experiment - intensity distribution of interference - phase change due to reflection - diffraction - narrow slit diffraction - single slit and two slit - intensity distribution - diffraction grating - applications

UNIT V **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation - twin paradox - length contraction - relativistic mass variation - space time graph. Black body radiation and Planck hypothesis - allowed energy levels - thermal radiation from different objects - photoelectric and Compton effect. Matter waves - de-Broglie hypothesis - wave nature of particles - Davission-Germer experiment

1 **5 Hours**

EXPERIMENT 1

Determination of resultant of system of concurrent coplanar forces-Parallelogram law of forces

2 **5 Hours**

EXPERIMENT 2

Determination of moment of inertia-Torsional pendulum

3 **5 Hours**

EXPERIMENT 3

Determination of wavelength of mercury spectral lines-spectrometer

4 **4 Hours**

EXPERIMENT 4

Determination of refractive index of solid and liquid-travelling microscope

5 **3 Hours**

EXPERIMENT 5

Determination of wavelength of laser-diffraction grating

6 **4 Hours**

EXPERIMENT 6

Determination of frequency of a tuning fork-Meldes apparatus

7 **4 Hours**

EXPERIMENT 7

Thickness of a thin wire using interference of light-Air wedge method

Total: 60 Hours

Reference(s)

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017
4. H D Young and R A Freedman, Sears and Zemanskys University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012

18EI103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- recall the terminologies of electrochemistry and apply it to find the electrode potential
- explain the sensing mechanism using electrodes in various instruments
- compare the efficiency of modified electrode for their applications in sensors
- interpret the concept of nanochemistry and their applications in sensors
- outline the fundamentals of corrosion, its types and protection methods

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

e. 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.

Course Outcomes (COs)

1. construct an electrochemical cell and measure its potential using selected reference electrode
2. classify the various types of sensors and analyze their mechanisms in various instruments
3. indicate the role of modified electrodes in sensor applications
4. outline the procedure of nanomaterial preparation and their applications in sensors
5. analyze the type of corrosion, factors influencing rate of corrosion on metals and identify suitable corrosion protection method

Articulation Matrix

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

UNIT I **7 Hours**

ELECTROCHEMISTRY

Electrodes- types of electrodes. Cells- types - applications - gas sensing electrodes - applications.

UNIT II **6 Hours**

SENSORS

Introduction - basic concepts - mechanism - applications of potentiometric, conductometric and amperometric based sensors.

UNIT III **5 Hours**

MODIFIED ELECTRODE FOR SENSORS

Comparison of electrodes to chemically modified electrode for sensors - conversion methods - microfabrication techniques for sensors.

UNIT IV **5 Hours**

NANO MATERIALS FOR SENSORS

Nano materials: Classification - properties - applications. Advantages over macromolecules - synthesis and properties and applications of nanomaterials based sensors.

UNIT V **7 Hours**

CORROSION PROTECTION

Corrosion - types- corrosion control methods: Electroplating (copper) - electroless plating (nickel) - applications in PCB.

FURTHER READING

Application of nanotechnology for electrical engineers. Electrical insulation polymers. Contact materials for electrical engineering applications.

1 **4 Hours**

EXPERIMENT 1

Determination of strength of HCl in a given solution using H ion sensing electrode

2 **8 Hours**

EXPERIMENT 2

i) Determination of strength of mineral acid by conductometric based sensor electrodes
ii) Determination of strength of mixture of acids (Hydrochloric acid and acetic acid) by conductometric titration.

3 **4 Hours**

EXPERIMENT 3

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode

4 **5 Hours**

EXPERIMENT 4

Preparation of Cadmium sulfide nano crystals using thiourea

5 **5 Hours**

EXPERIMENT 5

Synthesis of metal nanoparticles and their characterization

6 **4 Hours**

EXPERIMENT 6

Estimation of extent of corrosion of given metal by weight loss method

Total: 60 Hours

Reference(s)

1. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013.
2. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
3. S. Vairam, Engineering Chemistry, John Wiley & sons, 2014.
4. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnology, McGraw Hill, 2012.
5. Electrochemical Sensors, Biosensors and their Biomedical applications, X.Zhang, H.Zu,J. Wang, Elsevier Science and Technology Books, 2008
6. Microfabrication Techniques for Chemical/Biosensors, proceedings of the IEEE, vol. 91, No. 6, June 2003.

18EI104 COMPUTER PROGRAMMING I 2 0 2 3

Course Objectives

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

e. 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.

Course Outcomes (COs)

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and strings.
4. Design applications using functions in C.
5. Apply the concepts of structures and files in writing C programs.

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	1	2			3									
4	1	3			3									
5	1	3			3									

UNIT I **6 Hours**

INTRODUCTORY CONCEPTS

Introduction to C- Planning and writing a C program- Operators and Expressions- Arithmetic - Relational - Logical - Increment and decrement - Conditional - Bitwise - Comma – Sizeof () - Assignment - Shift operator Precedence and order of evaluation.

UNIT II **6 Hours**

CONTROL STATEMENTS

Decision Making and Branching- Decision Making and Looping -Jump Statements.

UNIT III **6 Hours**

ARRAYS AND STRINGS

Arrays- Introduction, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays. Strings- String handling functions.

UNIT IV **6 Hours**

FUNCTIONS

User Defined Functions- Elements of user defined functions - categories of function - call by value and call by reference - recursion

UNIT V **6 Hours**

STRUCTURES AND FILES

Structures - Introduction - defining a structure - declaring structure variables - accessing structure members -File Management in C.

FOR FURTHER READING

Problem solving - Logical thinking - logic - symbolic logic - truth tables - Math puzzles - magic triangles - magic squares - alphabetic puzzles - Cross number puzzles.

1 **2 Hours**

EXPERIMENT 1

Implement a C program which include a Fundamental Data types Integer, Float, double and Character.

2 **2 Hours**

EXPERIMENT 2

Implement a C program to perform the Arithmetic Operations using primitive data types.

3 **2 Hours**

EXPERIMENT 3

Implementation of logical, relational, bitwise, increment/decrement and conditional Operators in C.

4 **2 Hours**

EXPERIMENT 4

Implementation of Simple if else Conditional Statement.

5 **2 Hours**

EXPERIMENT 5

Implementation of nested if else Conditional Statement.

6 **2 Hours**

EXPERIMENT 6

Implementation of Switch Case Statement.

7 **2 Hours**

EXPERIMENT 7

Implement a C program using for Looping Statement.

8 **2 Hours**

EXPERIMENT 8

Implement a C program using Do-While Looping Statement.

9 **2 Hours**

EXPERIMENT 9

Implement a C program using While Looping Statement.

10 **2 Hours**

EXPERIMENT 10

Implementation of Jumping Statements

11 **2 Hours**

EXPERIMENT 11

Implementation of One Dimensional Array and Two Dimensional Array.

12 **2 Hours**

EXPERIMENT 12

Implement a C program to perform String Manipulation Functions.

13 **2 Hours**

EXPERIMENT 13

Implement a C program using structures and files

14 **2 Hours**

EXPERIMENT 14

Implement a C program which includes four categories of functions and recursive functions.

15 **2 Hours**

EXPERIMENT 15

Implement a C program for Call by value and Call by Reference.

Total: 60 Hours

Reference(s)

1. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2017
2. Byron Gottfried , Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Kernighan B W and Ritchie O M, The C programming Language. Prentice-Hall of India, 2009
5. Kelley A and I. Pohl, A Book on C : Programming in C, Pearson Education, 1998
6. Ashok.N.Kamthane,Programming in C,Pearson education,2013

18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

Programme Outcomes (POs)

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

j. 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.

k. 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. Use appropriate grammar and vocabulary that is expected at the BEC Preliminary exam level
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write formal, routine letters of factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

Articulation Matrix

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

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1.Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2.Our Casuarina Tree - Toru Dutt 3.Palanquin Bearers - Sarojini Naidu 4.The Tyger - William Blake 5.Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18EI106 ENGINEERING GRAPHICS 1 0 4 3

Course Objectives

- Provide knowledge on projection of points and lines.
- Impart skill in drawing projection of simple solids.
- Familiarize creation of orthographic views from isometric projections of simple solids and vice versa.
- Build the proficiency to create two dimensional sketches using software.
- Provide the skill to build three dimensional models and its orthographic views using software.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of 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.

e. 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.

j. 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. Illustrate the projection of points and lines in different quadrants.
2. Construct orthographic projections of simple solids.
3. Create the orthographic and isometric projections of simple solids.
4. Sketch the two dimensional views of engineering components using software.
5. Construct three dimensional models of engineering components and its orthographic views using software.

Articulation Matrix

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

UNIT I **6 Hours**

PROJECTION OF POINTS

Practices on lettering, numbering and dimensioning of drawings. Principles of projection, Projection of points in four quadrants, first angle projection of straight lines- parallel, perpendicular and inclined to anyone plane.

UNIT II **6 Hours**

PROJECTION OF SOLIDS

Orthographic projection of simple solids - parallel, perpendicular and inclined to one plane using change of position method.

UNIT III **6 Hours**

ISOMETRIC AND PERSPECTIVE PROJECTION

Conversion of isometric to orthographic projection and vice versa. Perspective projection of simple solids.

UNIT IV **6 Hours**

CREATION OF 2D SKETCHES USING SOFTWARE

Sketch Entities - line, circle, arc, rectangle, slots, polygon, text, snap, and grid. Sketch Tools-fillet, chamfer, offset, convert entities, trim, extend,mirror, move, copy, rotate, scale, stretch, sketch pattern. Geometrical constraints, Dimensioning - smart, horizontal, vertical, ordinate.

UNIT V **6 Hours**

PART MODELING AND DRAFTING USING SOFTWARE

Part Modeling- extrude, cut, revolve, creation of planes, fillet, chamfer, shell, rib, pattern, mirror, loft, draft and swept. Drafting - Converting 3D models to orthographic views with dimensions.

1 **9 Hours**

EXPERIMENT 1

Create 2D sketch of different components used in engineering applications.

2 **9 Hours**

EXPERIMENT 2

Create part model of a component from given isometric drawings.

3 **9 Hours**

EXPERIMENT 3

Create part model of a component from given orthographic views.

4 **9 Hours**

EXPERIMENT 4

Create an assembly model of product from detailed parts drawing.

5 **9 Hours**

EXPERIMENT 5

Create stl file from CAD model, transfer file to 3D printer, setup the machine parameters, build and post process the component using Additive Manufacturing Technology.

Total: 75 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International, 2005.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.

18EI201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

Course Outcomes (COs)

1. Illustrate the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Construct first order differential equations from real time phenomena and solve it by suitable method.
5. Execute the appropriate method to solve the second order differential equations.

Articulation Matrix

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

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only-Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

SEQUENCES AND SERIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoulli s equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

FOR FURTHER READING

Applications in Electromagnetic Fields, Applications in Communication Theory.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18EI202 ENGINEERING PHYSICS II 2 0 2 3

Course Objectives

- Understand the fundamentals of crystal, transport properties of semiconductors and magnetic materials
- Differentiate passive and active components
- Compare different display devices and their functions

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Identify the seven types of crystal systems, crystal planes and illustrate unit cell characteristics of SC, BCC, FCC and HCP crystal structures
2. Exemplify the characteristics of semiconducting materials in terms of crystal lattice, charge carriers and energy band diagrams
3. Differentiate the active and passive components in an electronic circuit and outline the working mechanisms of diodes
4. Analyse the properties of magnetic materials, domain theory of ferromagnetism and the applications of recording and readout process
5. Outline the interaction of electromagnetic radiation with matter and working principle of LED, LCD and OLED display devices

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							2					
4	2	1							2					
5	2	1							2					

UNIT I **6 Hours**

CRYSTAL PHYSICS

Classification of solids - crystal structure - lattice points and space lattice - unit cell and lattice parameters - crystal systems and Bravais lattices - crystallographic planes - Miller indices - interplanar space of lattice planes - anisotropic properties of crystal - unit cell characteristics of SC, BCC, FCC and HCP structures

UNIT II **7 Hours**

SEMICONDUCTING MATERIALS

Band theory of solids - classification of solids - electrical and thermal conductivity - Semiconductors: elemental and compound semiconductor - intrinsic and extrinsic semiconductors - energy band diagram and electrical conduction - variation of Fermi level with temperature and impurity concentration - temperature dependence of carrier concentration in extrinsic semiconductor - Hall effect - determination of Hall coefficient -solar cells.

UNIT III **5 Hours**

PASSIVE AND ACTIVE COMPONENTS

Fundamental definitions - types of resistors, capacitors, inductors and transformers - characteristics of PN junction. Diodes: laser diode - PIN diode - Schottky diode - step recovery diode - tunnel diode - varactor diode - Zener diode

UNIT IV **6 Hours**

MAGNETIC MATERIALS

Basic definitions - origin of magnetic moment - classification of magnetic materials - influence of temperature on magnetic behaviour - domain theory of ferromagnetism - hysteresis of ferromagnetic materials - soft and hard magnetic materials - applications: magnetic recording - giant magneto resistance (GMR) effect

UNIT V **6 Hours**

DISPLAY DEVICES

Electromagnetic radiation - interaction of radiation with solids - classification of optical materials - luminescence - types of luminescence - LED and OLED: principle, construction, working, advantages and disadvantages. LCD: characteristics of liquid crystals - types - phases - twisted nematic display: construction, working, merits and demerits. Comparison of LED, OLED and LCD

1 **5 Hours**

EXPERIMENT 1

Measurement of resistivity of a given material by four probe method

2 **5 Hours**

EXPERIMENT 2

Find the Hall coefficient and carrier concentration of semiconducting material using Hall effect apparatus

3 **5 Hours**

EXPERIMENT 3

Determine the V-I characteristics of a solar cell

4 **5 Hours**

EXPERIMENT 4

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor

5 **5 Hours**

EXPERIMENT 5

Determine the V-I characteristics of P-N diode and Zener diode

6 **5 Hours**

EXPERIMENT 6

Determine the thermal conductivity of a bad conductor by using Lee's disc method

Total: 60 Hours

Reference(s)

1. Balasubramaniam, R. "Callister""s Materials Science and Engineering". Wiley India Pvt.Ltd., 2014
2. Kasap, S.O. "Principles of Electronic Materials and Devices". McGraw-Hill Education,2017.
3. William D. Callister, Jr. & David G. Rethwisch "Fundamentals of Materials Science and Engineering".John Wiley and Sons Incl.,2008.
4. Wahab, M.A. "Solid State Physics: Structure and Properties of Materials". Alpha Science International Ltd., 2017.
5. Donald A. Neamen. "Semiconductor Physics and Devices", Mc Graw-Hill, 2011
6. Palanisamy P. K. "Physics for electronics and information science". Dipti Press Pvt. Ltd., 2018.

18EI203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- summarize the liquid and gas analysis techniques and its types.
- classify the types of the chromatography and predict their applications
- introduce the concept of spectroscopy and interpret their signals
- outline the basics of nuclear radiation techniques and their instrumentation
- outline the applications of conducting polymers in electronics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

Course Outcomes (COs)

1. assess the different types of liquid and gas analyzers used in various instruments
2. analyze the type of chromatographic techniques based on their surface adsorbing properties
3. identify the suitable spectroscopic techniques for determination of the compounds/metal ions
4. indicate the applications of NMR, ESR spectroscopy and diffractometer
5. classify commercially available conducting polymers and list its electronic applications

Articulation Matrix

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

UNIT I **6 Hours**

LIQUID AND GAS ANALYSIS

Dissolved oxygen analyser - sodium analyser - silica analyser - moisture measurement - oxygen analyser - CO monitor - NOx analyser - H2S analyser - dust and smoke measurement - thermal conductivity type - thermal analyser - industrial analysers

UNIT II **6 Hours**

CHROMATOGRAPHY

Chromatography - gas chromatography - detectors - liquid chromatography - applications - High - pressure liquid chromatography - applications

UNIT III **6 Hours**

SPECTROSCOPY

Spectroscopy: Electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions. UV visible and IR spectroscopy - principle, instrumentation (block diagram) and applications

UNIT IV **6 Hours**

MAGNETIC AND RADIATION TECHNIQUES

Nuclear radiation - NMR, ESR spectroscopy - applications - nuclear radiation detectors - GM counter - X-ray spectroscopy and diffractometer- applications

UNIT V **6 Hours**

POLYMERS

Polymers- conducting polymers- physical and chemical properties of commercial/electronic polymers and their applications. Polymers in optical media data storage devices

FOR FURTHER READING

i.Document the various batteries with its characteristics/specifications used in mobile phones, automobiles and laptops ii. Maintenance free batteries, battery recycling

1 **4 Hours**

EXPERIMENT 1

Estimation of DO in given water sample by Winkler s method

2 **3 Hours**

EXPERIMENT 2

Preparation of TLC plate and their analysis

3 **3 Hours**

EXPERIMENT 3

Preparation of columns used in column chromatography and analyze the given sample.

4 **4 Hours**

EXPERIMENT 4

Identify the functional groups of a given sample using IR spectroscopy.

5 **4 Hours**

EXPERIMENT 5

Determination of iron (thiocyanate method) in the given solution by spectrophotometric method

6 **4 Hours**

EXPERIMENT 6

Determination of strength in the given dye solution by application UV visible radiation.

7 **4 Hours**

EXPERIMENT 7

Interpretation of structural details based on the given data obtained by XRD.

8 **4 Hours**

EXPERIMENT 8

Determination of molecular weight of given polymer by Ostwald viscometer

Total: 60 Hours

Reference(s)

1. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013
2. H.H. Willard, L. L. Merrit, J. A. Dean and F. L. Seattle, Instrumental Methods of Analysis, CBS Publishing Co, New York,2010
3. D. A. Skoog and D. M. West, Principles of Instrumental Analysis, Holt Sounder Publication, Philadelphia, 2007
4. Robert D. Braun, Introduction to Instrumental Analysis, McGraw Hill book Co, New York, 2006
5. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014
6. Douglas A. Skoog, F James Holler and Stanley R. Crouch, Principles of Instrumental analysis, Thomson, Brooks/Cole, Belmont, Canada, 2007.

18EI204 ELECTRIC CIRCUIT ANALYSIS 3 1 0 4

Course Objectives

- To formulate the solution for basic electric circuit problems
- To differentiate single phase and three phase circuits.
- To compute electrical parameters like current, voltage and power using network theorems
- To impart knowledge in resonance and coupled circuits
- To analyze the transient response of RL and RC series circuits and to solve problems in time domain using Laplace Transform

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

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

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.

Course Outcomes (COs)

1. Solve the DC Electric circuit problems using mesh and node analysis
2. Analyse the basic concepts of AC circuits
3. Apply network theorems to find solutions for electric circuits
4. Identify the behavior of resonance and coupled circuits
5. Analyze the transient response of RL and RC series circuits

Articulation Matrix

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

UNIT I **8 Hours**

DC CIRCUITS

Electric circuit components - Ohm's law - statement, Illustration and limitation - Kirchoff's laws statement and Illustration -Resistance in series and voltage division technique - Resistance in parallel and current division technique - Simple problems - Mesh loop current method - Nodal voltage method

UNIT II **9 Hours**

AC CIRCUITS

Types of waveforms - Advantages of Sinusoidal waveform - Average Value and RMS Value - Form factor and Peak factor - V-I relationships between R, L and C - Phasor relation in pure resistor, inductor and capacitor - Power and power factor - Concepts of impedance and admittance - Analysis of simple circuits - Three phase AC waveform - Phase sequence - Advantages of three phase circuits

UNIT III **10 Hours**

NETWORK THEOREMS AND ITS APPLICATIONS

Super position theorem - Thevenins theorem - Nortons theorem - Maximum power transfer theorem - Star Delta Transformations

UNIT IV **10 Hours**

RESONANCE

Series resonant circuits - Bandwidth of an RLC circuit - Q factor and its effect on bandwidth - Parallel resonance -Simple problems on resonance - Applications of resonance - Coupled circuits - Self and mutual inductance - Inductances in series and parallel - Mutual and leakage flux - Coefficient of coupling

UNIT V **8 Hours**

TRANSIENTS

Introduction - Transient response of RL & RC series circuits with step and ramp inputs - Time Constant - Rise and fall times

FOR FURTHER READING

Reciprocity theorem, substitution theorem

Total: 60 Hours

Reference(s)

1. A. Sudhakar and S. P. Shyam Mohan, Circuits and Network Analysis and Synthesis, Tata McGraw Hill, 2017
2. Charles K.Alexander, Fundamentals of Electric Circuits, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2015
3. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Tata McGrawHill Publishing Co Ltd, New Delhi, 2012
4. Ravish R Singh, Electrical Networks, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2012

18EI206 COMPUTER PROGRAMMING II 2 0 2 3

Course Objectives

- Design, write, debug, run C++ and Java Programs.
- Develop console based applications using C++.
- Develop Console and windows applications using Java.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.

Course Outcomes (COs)

1. Design class and objects for real world scenario.
2. Apply Inheritance concept to obtain code reusability.
3. Create applications to manipulate data from files using functions and streams
4. Develop console applications using Java OOPS.
5. Develop GUI application using Java library classes.

Articulation Matrix

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

UNIT I **6 Hours**

CLASSES AND OBJECTS

Overview of OOPs Principles - Introduction to classes & objects - Instantiating and Using Classes with objects - Data Members - Member Functions - this Pointer - Constructor & Destructor - Control Structures - Arrays and Strings in C++ - Static class member

UNIT II **6 Hours**

INHERITANCE

Derived Class and Base Class - Derived Class Constructors - Overriding Member Functions - Public and Private Inheritance - Types of Inheritance: Single, Multi Level, Multiple, Hierarchical and Hybrid - Virtual Base Classes - Abstract Classes.

UNIT III **6 Hours**

FUNCTIONS AND STREAMS

Pointers - this Pointer - Pointers to Objects and Derived Classes - Function Overloading - Operator Overloading - Virtual Function - Friend Function - Static Function - Streams: Stream Classes - Unformatted I/O Operations - Formatted Console I/O Operations

UNIT IV **6 Hours**

JAVA OOPS BASICS

Java Basics - Classes and Objects - Inheritance- Interfaces - Abstract Class - packages - Exception handling- Strings - Type wrappers

UNIT V **6 Hours**

JAVA COLLECTIONS AND IO

Generics - Collections -Java Utility Classes - I/O Classes and Interfaces-Java Database Connectivity-Multithreading- Java swing basics

FOR FURTHER READING

Java swing basics

1 **3 Hours**

EXPERIMENT 1

Introduction to OOP lab (Simple C program) - Classes and Objects

2 **3 Hours**

EXPERIMENT 2

Programs using inheritance

3 **3 Hours**

EXPERIMENT 3

Programs using static polymorphism

4 **3 Hours**

EXPERIMENT 4

Programs on dynamic polymorphism

5 **3 Hours**

EXPERIMENT 5

Programs on operator overloading

6 **3 Hours**

EXPERIMENT 6

Programs on dynamic memory management using new, delete operators

7 **3 Hours**

EXPERIMENT 7

Programs on copy constructor and usage of assignment operator

8 **3 Hours**

EXPERIMENT 8

Programs on exception handling

9 **3 Hours**

EXPERIMENT 9

Programs on generic programming using template function

10 **3 Hours**

EXPERIMENT 10

Programs on file handling

Total: 60 Hours

Reference(s)

1. E Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2011.
2. Robert Lafore, Object Oriented Programming in C++, Galgotia Publication, 2010.
3. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education,2018.
4. D.T. Editorial Services, Java 8 Programming Black Book, second edition, Dreamtech Press,2015.

18EI207 ENGINEERING PRACTICES LABORATORY

0 0 4 2

Course Objectives

- To measure the electrical and physical parameters using suitable instruments for different application.
- To Construct manual P&ID Diagram for the existing flow control loop.
- To Identify different basic elements of PLC, field Instruments, Controller and communication devices.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
e. 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.
k. 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.
ms. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Select and use the proper instruments to measure the electrical parameters in AC and DC power circuits.
2. Carry-out the procedure to measure mechanical parameters such as distance, force, touch, vibration and pressure using suitable instruments.
3. Use suitable sensors for measuring the physical parameter such as temperature, humidity, moisture, turbidity and sound.
4. Construct manual P&ID Diagram for the existing flow control loop.
5. Identify different basic elements of PLC, field Instruments, Controller and communication 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		2	
2	3	2	2		1						1		2	
3	3	2	2		1						1		2	
4	3	2	2		1						1		2	
5	3	2	2		1						1		2	

1 **6 Hours**

EXPERIMENT 1

(i) Measurement of resistance, capacitance, inductance used in DC power source circuit
(ii) Measurement of voltage, current and power in a DC power source circuit by connecting a load.
(iii) Linear and Nonlinear system identification using resistive and RLC circuit.

2 **6 Hours**

EXPERIMENT 2

(i) Measurement of vibration in a given plateform in terms of frequency and amplitude using vibromenter
(ii) Phase angle measurement in an inductive load (ex: fan, motor) using CRO.

3 **6 Hours**

EXPERIMENT 3

Identification of diode, transistors, IC's and transformer used in CRO, function generator, transmitter and power supply circuit.

4 **6 Hours**

EXPERIMENT 4

(i) Measurement of temperature using thermistor, RTD and Thermocouple.
(ii) Measurement of air pressure using strain gauge and Bourdon tube based pressure gauge.
(iii) Diffrential pressure measurement using differential pressure transmitter in a water tank
(iii) Measurement of level using capacitive and differential pressure transmitter
(iv) Water flow measurement using orifice

5 **6 Hours**

EXPERIMENT 5

(i) Measurement of water turbidity using photoelectric sensor
(ii) Touch measurement using capcitive
(iii) Force measurement using piezoelectric sensor and strain gauge
(iv) Distance measurement using photoelectric and ultrasonic sensors
(v) Velocity/speed measurement using LVDT and tachometer.

6 **6 Hours**

EXPERIMENT 6

(i) Measurement of humidity using Capacitive Relative Humidity (RH) Sensors,
(ii) Soil moisture measurement using conductivity sensor
(iii) Sound measurement using desibal meter and micro phone.

7 **6 Hours**

EXPERIMENT 7

(i) Light/fan ON-OFF using relay switch
(ii) Flow control using motor and solenoid valve.

8 **6 Hours**

EXPERIMENT 8

Wired communication between field instruments and controller (CPU/PC) with RS232, RS485, USB, Ethernet, and Coaxial Cable.

9 **6 Hours**

EXPERIMENT 9

P and I D symbols and diagram for flow control loop.

10 **6 Hours**

EXPERIMENT 10

Identification of PLC parts (SMPS, input device, output device, CPU, relay, fuses communication cables, PLC software and its accessories).

Total: 60 Hours

18EI301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Understand the concepts of Fourier series, Partial differential equations, Transforms and Boundary Conditions, 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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Represent the periodic and aperiodic motions of electrical appliances with the help of Fourier Analysis.
2. Find the position of a moving particle which are depending on more than one parameter, using partial differential equations.
3. Formulate a function in frequency domain for which the function defined in time domain through the techniques of Laplace transforms.
4. Use the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Summarize and analyse the properties of the parameters of any electrical process with the help of the optimization techniques.

Articulation Matrix

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

UNIT I **10 Hours**

FOURIER ANALYSIS

Fourier series for periodic functions. Orthogonal functions. The Euler coefficients. Fourier transforms. Properties of Fourier transform. Applications of Fourier series and transform analysis.

UNIT II **10 Hours**

PARTIAL DIFFERENTIAL EQUATION

Introduction to partial differential equations. One-dimensional wave equation. Method of separation of variables. DeAlembert s solution of the wave equation. Heat equation. Laplace equation. Telegraph equations. Laplace transform method of solution.

UNIT III **9 Hours**

LAPLACE TRANSFORM

Properties and theorems of Laplace transform. Shifting theorems. Inverse Laplace transform, Convolution. Applications to ordinary differential equations. Applications to linear system analysis.

UNIT IV **8 Hours**

Z - TRANSFORM

Z-Transform, Elementary Properties, Inverse Z-Transform, Convolution Method- Partial fraction method, Solution of Difference Equations using Z-Transform.

UNIT V **8 Hours**

OPTIMIZATION TECHNIQUES

Introduction to linear programming model, Mathematical formulation, Graphical Method, Simplex method, Big M method (penalty method).

FOR FURTHER READING
Fast Fourier Analysis, Applications of PDE in heat flow

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. O'Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995.
3. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
4. Hamdy A. Taha, Operations Research, an Introduction, 10th Edition, Pearson, 2017
5. Kanti Swarup, P. K. Gupta, Man Mohan, Operations Research, 15 th Edition, Sultan Chand & sons, 2007.

18EI302 ELECTRICAL MACHINES AND DRIVES 2 0 2 3

Course Objectives

- To impart knowledge on constructional details, principle of operation, performance characteristics and starters of D.C machines
- To understand the constructional details, principle of operation, equivalent circuit and performance of transformers
- To identify the constructional details, types, principle of operation and performance of single phase and three phase induction motors
- To understand the concepts of Electrical Drives
- To know the speed control characteristics of DC motors and Induction motor

Programme Outcomes (POs)
a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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. Understand the construction, working principle and characteristics of DC machines.
2. Determine the transformer equivalent circuit parameters
3. Interpret the construction, working principle and characteristics of single phase and three phase induction motors
4. Analyze the concepts of Electrical Drives and selection of motor and its power rating
5. Examine the speed control characteristics of DC motors and Induction motor

Articulation Matrix

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

UNIT I **6 Hours**

D.C. MACHINES

Constructional details - Principle of operation of D.C. generator - EMF equation - Methods of excitation - Self and separately excited generators - Characteristics of series, shunt and compound generators - Principle of operation of D.C. motor - Back EMF and torque equation - Characteristics of series, shunt and compound motors - Starting of DC motors - Types of starters - Working of three point starter

UNIT II **5 Hours**

TRANSFORMERS

Constructional details - Principle of operation - EMF equation - Transformation ratio - Transformer on no load and Load - Parameters referred to HV/LV windings - Equivalent circuit - Regulation - Load test, open circuit and short circuit tests - Problems on equivalent circuit

UNIT III **6 Hours**

SINGLE PHASE AND THREE PHASE INDUCTION MOTORS

Single Phase Induction Motor: Construction - Working principle - Types - Split Phase Induction Motor - Capacitor Start Induction Motor - Capacitor Start and Capacitor Run Induction Motor - Shaded Pole Induction Motor - Applications - Three Phase Induction Motor: Principle of operation - Squirrel Cage rotor - Wound rotor - Torque equation - Torque-Slip Characteristics - Applications

UNIT IV **5 Hours**

ELECTRICAL DRIVES

Electrical Drives: Introduction, Advantages and Types - Selection of Electrical Drives - General Electric Drive System - Parts of Electrical Drives - Applications - Selection of motor and its power rating

UNIT V **8 Hours**

SPEED CONTROL OF MOTORS

Speed control of DC Shunt Motor - Speed control of DC Series Motor - Ward-leonard control system - Speed control of Induction motor - Stepper Motor Drives - Servo Motor Drives - VFD Drives

FOR FURTHER READING

Working principle of Syncro motors and its applications

1 **6 Hours**

EXPERIMENT 1

Load test on DC shunt motor

2 **6 Hours**

EXPERIMENT 2

Speed control of DC shunt motor

3 **6 Hours**

EXPERIMENT 3
Load test on single phase transformer

4 **6 Hours**

EXPERIMENT 4
Speed control of DC Series motor

5 **6 Hours**

EXPERIMENT 5
Speed control of Induction motor

Total: 60 Hours

Reference(s)

1. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, 2016
2. B.L.Theraja, Textbook(s) of Electrical Technology, S.Chand publications, 2018
3. S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill publishing company Ltd, 2014
4. Electrical Machines and Drives, Anuradha Publications, 2016
5. A.E.Fitzgerald and Stephen Umans, Electric Machinery, Tata McGraw Hill publishing company Ltd, 2014

18EI303 FLUID MECHANICS AND THERMO DYNAMICS

3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

FLUID PROPERTIES AND KINEMATICS

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

UNIT II **9 Hours**

FLUID DYNAMICS AND HYDRAULIC PUMPS

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

UNIT III **9 Hours**

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

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

UNIT IV **9 Hours**

INTERNAL COMBUSTION ENGINES AND AIR STANDARD CYCLES

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

UNIT V **9 Hours**

REFRIGERATION AND AIR CONDITIONING

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

FOR FURTHER READING

Steam Turbine, Pressure Cooker, Steam Nozzles - Applications of IC engines - Cogeneration Steam power plant - Centrifugal compressors , mixed-flow compressors- Domestic Refrigerator, Automobile Air Conditioning Systems, Thermoelastic cooling

Total: 60 Hours

Reference(s)

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

18EI304 ELECTRON DEVICES AND CIRCUITS 3 1 0 4

Course Objectives

- To illustrate the operation of various semiconductor devices and its applications.
- To analyze the characteristics of BJT and FET.
- To outline the operation of amplifiers and oscillators.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Attribute the Voltage and Current characteristics of semiconductor devices and its applications.
2. Design biasing and modeling circuits for amplifier using BJT
3. Design biasing and modeling circuits for amplifier using FET
4. Implement design procedure for feedback circuit and five types of oscillator circuits.
5. Construct the Power amplifier circuits and tuned amplifier circuits using BJT.

Articulation Matrix

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

UNIT I **9 Hours**

SEMICONDUCTOR DIODES AND APPLICATIONS

Introduction to Semiconductor Devices, Construction and V-I Characteristics : UJT, SCR, P-N junction Diode as a Rectifier, Half wave Rectifier, Full wave Rectifier, Bridge Rectifier, Inductor Filters, and Capacitor Filters, Voltage Regulation using Zener Diode.

UNIT II **9 Hours**

BJT BIASING AND MODELING

Principle of operation of PNP and NPN transistors -study of CE, CB and CC configurations and comparison of their characteristics, DC Load line, operating point, various biasing methods for BJT- Design Stability- Thermal run away, BJT Modeling- Determination of h-parameters Analysis of a transistor amplifier circuit using h-parameters.

UNIT III **9 Hours**

FET BIASING AND MODELING

The Junction Field Effect Transistor(JFET)-Pinch-off Voltage - Drain and Transfer characteristics, MOSFET Characteristics in Enhancement and Depletion modes, FET Biasing-Fixed bias, Self bias, Voltage divider bias , JFET Small Signal Model- Fixed bias configuration, Self bias configuration, Voltage divider bias configuration.

UNIT IV **9 Hours**

FEEDBACK CIRCUITS AND OSCILLATOR CIRCUITS

Feedback concepts, Feedback connection types, Practical feedback circuits - Theory of sinusoidal oscillators - Phase shift oscillator, Wien bridge oscillator - Colpitt's oscillator, Hartley oscillator, Crystal oscillator.

UNIT V **9 Hours**

DIFFERENTIAL AMPLIFIER AND TUNED AMPLIFIER

Differential amplifiers: Common mode analysis, differential mode analysis, DC analysis, AC analysis. Transformer coupled class A, B amplifiers and class B Push-pull amplifiers. Tuned amplifiers: Characteristics, Single tuned amplifiers, double tuned amplifiers

FOR FURTHER READING

Design of constant DC voltage source, Transistor as an amplifier, FET as a switch, Quartz clock, differential amplifier in operational amplifier, Tuning of sound system.

Total: 60 Hours

Reference(s)

1. Jacob. Millman, Christos C. Halkias and Sathyabrata Jit, Electronic Devices and Circuits, Tata McGraw Hill, New Delhi, 2015
2. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory, Pearson Education, Tenth edition, 2012.
3. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2017.
4. Theodre F. Boghert, Electronic Devices & Circuits, Pearson Education, Sixth edition, 2011.
5. David A. Bell, "Electronic devices and circuits", Oxford University higher education, 5th edition 2008.

18EI305 DIGITAL LOGIC CIRCUITS 3 1 0 4

Course Objectives

- To study various number systems and to simplify the mathematical expressions using Boolean functions
- To study the implementation of combinational circuits
- To study the design of various synchronous and asynchronous circuits
- To expose the students to various memory devices

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
j. 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. Interpret various number systems and simplifications using K-maps.
2. Design the combinational logic circuits for given real time problems.
3. Implement the Sequential logic circuits for given application.
4. Apply the Concept of state transition and analyse the design of sequential circuit.
5. Analyze the digital system design using PLD and interpret the logic families.

Articulation Matrix

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

UNIT I **9 Hours**

NUMBER SYSTEM

Review of number system; Types and conversion codes - Boolean algebra: De-Morgan's theorem - switching functions and simplification using K-maps & Quine McCluskey method.

UNIT II **9 Hours**

COMBINATIONAL CIRCUITS

Design using logic gates - Design of adders, subtractors, comparators, code converters, encoders, decoders, Multiplexers and demultiplexers -Function realization using multiplexers.

UNIT III **9 Hours**

SYNCHRONOUS SEQUENTIAL CIRCUITS

Flip flops - SR, JK - MSJK, D and T - Shift Registers - Analysis of synchronous sequential circuits; Design of synchronous sequential circuits - Moore and Melay models - Counters,Timers, state diagram; state reduction; state assignment.

UNIT IV **9 Hours**

ASYNCHRONOUS SEQUENTIAL CIRCUITS

Analysis of asynchronous sequential machines - State assignment - Asynchronous design problem - Difference between Synchronous and Asynchronous Sequential Circuits.

UNIT V **9 Hours**

LOGIC FAMILIES AND MEMORY DEVICES

Logic Families: TTL, ECL, CMOS - Memories: ROM, PROM, EPROM - Study of memory ICs - Control signals and their programming - Programmable Logic Devices: PLA, PAL, PLD and FPGA.

FOR FURTHER READING

Applications of Digital Circuits - Real time Digital Clock - Digital counter in industries

Total: 60 Hours

Reference(s)

1. M. Morris Mano, Digital Design with an introduction to the VHDL, Pearson Education, 2013.
2. Comer, Digital Logic & State Machine Design, Oxford, 2012.
3. James W. Bignel, Digital Electronics, Cengage learning, 5th Edition, 2007.
4. Mandal, Digital Electronics Principles & Application, McGraw Hill Edu, 2013.
5. William Keitz, Digital Electronics-A Practical Approach with VHDL, Pearson, 2013.
6. Thomas L.Floyd, Digital Fundamentals, 11th edition, Pearson Education, 2015.

18EI306 COMPUTER PROGRAMMING III 2 0 2 3

Course Objectives

- Understand the history and basics of python
- Gain knowledge about the different data types and control flow statements
- Impart knowledge about the functions, files, list, set tuples and dictionaries

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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. Implement simple python programs using input output operations
2. Develop python programs using expressions and statements
3. Implement python programs using control flow statements and strings
4. Apply the concepts of functions and files in python programming
5. Design applications using list, sets, tuples and dictionaries in python

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										
4	2	3		3										
5	2	3		3										

UNIT I **6 Hours**

INTRODUCTION

What is Python - History of Python - Features of Python - Simple Program in Python - Commenting in Python - Quotations in Python - Lines and Indentation - Multi-Line Statements - Input Operations - Output Operations.

UNIT II **6 Hours**

DATA, EXPRESSIONS AND STATEMENTS

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III **6 Hours**

CONTROL FLOW STATEMENTS AND STRINGS

if statement - if-else statement - if-elif-else statement - Nested if - While loop - for loop - else statement used with loops - break statement - continue - pass statement - Strings: string slices - immutability - string functions and methods - In-built string methods - string formatting operations - string module.

UNIT IV **6 Hours**

FUNCTIONS AND FILES

Functions: return values - parameters - local and global scope - function composition - recursion; Files: Reading and Writing-Format Operators-Filenames and paths.

UNIT V **6 Hours**

LIST, SET AND TUPLES

Lists as arrays - Lists: list operations - list slices - list methods - list loop - mutability - aliasing - cloning lists - list parameters; Set; Tuples: tuple assignment, tuple as return value;

FOR FURTHER READING

Dictionaries: operations and methods.

1 **2 Hours**

EXPERIMENT 1

Program to implement basic operators.

2 **2 Hours**

EXPERIMENT 2

Program for Operator Precedence.

3 **3 Hours**

EXPERIMENT 3

Program to implement the concept of function.

4 **3 Hours**

EXPERIMENT 4

Develop the program for selection statements.

5 **3 Hours**

EXPERIMENT 5

Program to implement looping statements.

6 **2 Hours**

EXPERIMENT 6

Program to implement break and continue statements.

7 **3 Hours**

EXPERIMENT 7

Develop a program to implement the concept of Recursion.

8 **3 Hours**

EXPERIMENT 8

Program to implement string functions.

9 **3 Hours**

EXPERIMENT 9

Implement the concept of list.

10 **3 Hours**

EXPERIMENT 10

Develop a program to implement tuples.

11 **3 Hours**

EXPERIMENT 11

Program to implement set, dictionaries.

Total: 60 Hours

Reference(s)

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python - Revised and updated for Python 3.2", Network Theory Ltd., 2014.
3. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2015.
4. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2017

18EI307 ELECTRON DEVICES AND CIRCUIT LABORATORY

0 0 2 1

Course Objectives

- To illustrate the VI characteristics semi conductor devices.
- To determine the various parameters of solid state devices by experimentally.
- To analyze the application of solid state devices.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Implement voltage regulator and converter circuit for given real time applications
2. Analyze the h-parameters of BJT under CE, CB Configuration.
3. Analyze the transfer characteristics of FET.
4. Design an oscillator circuit using R, L, C components.
5. Design an amplifier circuit using Transistors

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Design a Half wave and Full wave Rectifier using PN junction diode.

2 **3 Hours**

EXPERIMENT 2

Design a voltage regulator using Zener diode.

3 **3 Hours**

EXPERIMENT 3

Determine h-parameters for a transistor under CE configuration.

4 **3 Hours**

EXPERIMENT 4

Determine h-parameters for a transistor under CB configuration

5 **3 Hours**

EXPERIMENT 5

Determine transcondutance and transresistance of JFET.

6 **3 Hours**

EXPERIMENT 6

Determine transcondutance and transresistance of MOSFET.

7 **3 Hours**

EXPERIMENT 7

Design of audio frequency oscillator.

8 **3 Hours**

EXPERIMENT 8

Design of radio frequency oscillator.

9 **3 Hours**

EXPERIMENT 9

Design a differential amplifier circuit using BJT.

10 **3 Hours**

EXPERIMENT 10

Design a Class A power amplifier using BJT.

Total: 30 Hours

Reference(s)

1. Jacob. Millman, Christos C. Halkias and Sathyabrata Jit, Electronic Devices and Circuits, Third Edition, Tata McGraw Hill, New Delhi, 4th Edition,2015.
2. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory, 11th edition, Pearson Education, 2012
3. Theodre F. Boghert, Electronic Devices & Circuits, Sixth edition, Pearson Education, 2011

18EI308 FLUID MECHANICS AND THERMO DYNAMICS LABORATORY

0 0 2 1

Course Objectives

- Expertise in the various thermodynamic concepts and principles
- Reinforce and enhance the understanding the fundamentals of Fluid mechanics and Hydraulic machines
- Provide practice in making engineering judgments, estimates and assessing the reliability of your measurements, skills which are very important in all engineering disciplines

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.

Course Outcomes (COs)

1. Explain the fluid properties using fundamental laws of fluid mechanics
2. Analyze the volume flow rates and losses occur in a flow through pipes.
3. Interpret flow rate and discharge level of pumps
4. Recognize the components and compute the valve and port timings of internal combustion engines
5. Estimate the capacity of refrigeration and air conditioning system

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Find out the Viscosity value of the given oil sample by using Red Wood Viscometer

2 **3 Hours**

EXPERIMENT 2

Find out the Flash Point and Fire Point Temperature of the given fuel samples

3 **3 Hours**

EXPERIMENT 3

Determine the coefficient of discharge of given Orifice meter

4 **3 Hours**

EXPERIMENT 4

Determine the coefficient of discharge of given Venturimeter

5 **3 Hours**

EXPERIMENT 5

Determination of friction factor for a given set of pipes

6 **3 Hours**

EXPERIMENT 6

Analyze the performance of centrifugal pump by varying the discharge level of the water

7 **3 Hours**

EXPERIMENT 7

Experimental study on port timing diagram of IC engines

8 **3 Hours**

EXPERIMENT 8

Experimental study on valve timing diagram of IC engines

9 **3 Hours**

EXPERIMENT 9

Experimental study on determination of Coefficient of Performance of refrigeration system

10 **3 Hours**

EXPERIMENT 10

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

Total: 30 Hours

18GE301 SOFT SKILLS - VERBAL ABILITY 0 0 2 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To read and understand unabridged text
- To help students become proficient in basic writing skills related to work place communication

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. 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.
k. 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. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

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

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

18EI401 ENGINEERING MATHEMATICS IV 3 1 0 4

Course Objectives

- Understand the basic concepts of probability and the distributions with characteristics of one dimensional random variables.
- Analyze the various data by different numerical and statistical sampling techniques.
- 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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
2. Analyze the various data by different numerical techniques.
3. Analyze the various collection of data in science / engineering problems using statistical inference techniques.
4. Verify the validity of an argument using propositional and predicate logic and apply graph theory models of data structures and state machines to solve problems of connectivity and constraint satisfaction.
5. Apply the concept of error analysis and finite element analysis techniques in their core area

Articulation Matrix

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

UNIT I **8 Hours**

PROBABILITY THEORY

Probability. Random variables, probability densities and distributions, mean and variance of a distribution. Conditional probability. Bayes theorem. Binomial, Poisson and normal distributions.

UNIT II **10 Hours**

NUMERICAL METHODS

Single and multi-variable nonlinear equations, convergence of fixed point iterations. Least squares approximation, Normal equations. Polynomial interpolation and cubic spline interpolation. Single step methods, Runge-Kutta methods. Multi-step methods. Finite Difference Methods.

UNIT III **10 Hours**

MATHEMATICAL STATISTICS

Sample mean and variance. Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses, one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

UNIT IV **7 Hours**

SET THEORY AND GRAPHS

Sets: Relations, Equivalence relations, Functions. Graphs: Graph Isomorphism, connected Graphs, Trees, Shortest path problem.

UNIT V **10 Hours**

FINITE ELEMENT ANALYSIS AND ERROR ANALYSIS

Introduction to finite element methods, solutions to discrete and continuous system mathematical model, Errors, Truncation and round off errors, measurement errors, Chebychev's Polynomial and data filtering.

FOR FURTHER READING

Decision Making Algorithm

Total: 60 Hours

Reference(s)

1. Greenberg Michael D., Advanced Engineering Mathematics, Prentice-Hall International Inc, 1998.
2. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
3. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
4. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
5. Kenneth H Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, Seventh Edition, Seventh Edition, Mc Graw Hill Education India Private Limited, New Delhi, 2013.
6. Klaus-Jurgen Bathe, Finite Element Procedures, Pearson Education, Inc., 2nd edition: fourth printing 2016.

18EI402 ELECTRICAL AND ELECTRONIC MEASUREMENTS

3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Outline the construction and working principle of measuring instrument to measure voltage and current
2. Examine the working principle of different watt meters and energy meters.
3. Compare the different types of potentiometers and instrument transformers
4. Apply the various bridge techniques for the measurement of resistance and impedance in AC and DC circuits
5. Use the appropriate display and recording devices and analyze the measurement of current, voltage and frequency using CRO

Articulation Matrix

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

UNIT I **7 Hours**

MEASUREMENT OF VOLTAGE AND CURRENT

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

UNIT II **9 Hours**

MEASUREMENT OF POWER AND ENERGY

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

UNIT III **9 Hours**

POTENTIOMETERS AND INSTRUMENT TRANSFORMERS

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

UNIT IV **12 Hours**

MEASUREMENT OF RESISTANCE AND IMPEDANCE

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

UNIT V **8 Hours**

DISPLAY AND RECORDING DEVICES

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

FURTHER READING

Digital voltmeter: Integrating type, staircase ramp type, 3.5 digit display, resolution and sensitivity of digital meters - Digital multimeter - digital frequency meter - Digital measurement of time.

Total: 45 Hours

Reference(s)

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

18EI403 CONTROL ENGINEERING 3 0 2 4

Course Objectives

- To Study the principles of system modelling, system analysis and feedback control, and use them to design and evaluate feedback control systems with desired performance.
- Control system modelling: modelling of electric and mechanical systems, using differential equations, transfer functions, block diagrams, and state variables.
- Control system analysis: analysis of properties of control systems, such as stability, controllability, tracking, in time and frequency domains.
- Control system design: design of feedback controllers, such as PID, lead and lag compensators to meet desired system performance specifications.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of 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.
d. 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. Formulate the transfer function model of electrical and mechanical systems.
2. Determine the time response and steady error for the different order systems to various inputs.
3. Analyze performance characteristics of system using frequency response methods.
4. Investigate the stability of the control system and design the lead, lag, lag-lead compensators in time domain.
5. Express and solve the system equations in state variable forms.

Articulation Matrix

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

UNIT I **9 Hours**

MATHEMATICAL MODEL OF PHYSICAL SYSTEMS

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

UNIT II **7 Hours**

TIME DOMAIN ANALYSIS

Time response - Time domain specifications -Types of test input - Time response analysis - I and II order system response - Steady state errors and error constants - Concepts and applications of P, PD, PI and PID - types of control.

UNIT III **10 Hours**

FREQUENCY DOMAIN ANALYSIS

Frequency response - Frequency domain specifications - Polar plot - Bode plot - Nyquist plot - The Nyquist stability criterion - Correlation between frequency domain and time domain specifications.

UNIT IV **12 Hours**

STABILITY ANALYSIS AND COMPENSATOR DESIGN USING TIME DOMAIN

Concepts of stability - Characteristic equation - Routh Hurwitz criterion - Root Locus technique - Design Specifications - Lag, lead and lag-lead networks - Cascade compensator design using time domain analysis.

UNIT V **7 Hours**

STATE VARIABLE ANALYSIS

Concept of state variables - State models for linear and time invariant systems - State transition matrix - controllability - observability.

FOR FURTHER READING

Transfer function of Speed Controlled DC motor - Transient response of thermistor - Performance analysis of PI, PD and PID controller for thermal process - Stability analysis of linear system - State space representation using electromechanical system.

1 **5 Hours**

EXPERIMENT 1

Modelling of the Servo motor in transfer function and State space

2 **5 Hours**

EXPERIMENT 2
Time response analysis using MATLAB

3 **5 Hours**

EXPERIMENT 3
Frequency response analysis using MATLAB

4 **5 Hours**

EXPERIMENT 4
Stability analysis of LTI systems

5 **5 Hours**

EXPERIMENT 5
Performance analysis of P, PI, PD and PID controllers

6 **5 Hours**

EXPERIMENT 6
Compensator design using MATLAB

Total: 75 Hours

Text Book(s)

1. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, 2011.
2. K. Ogatta, Modern Control Engineering, Pearson Education, New Delhi, 2010.
3. Benjamin C. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd. 2012
4. M. Gopal, Control System Principles and Design, Tata McGraw-Hill, 2012
5. M. N. Bandyopadhyay, Control Engineering Theory and Practice, Prentice Hall of India, 2009
6. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2003. (Indian edition)

18EI404 TRANSDUCER ENGINEERING 3 0 0 3

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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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. 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	PSO 2
1	1	2	3											
2	1	2												
3	1	2	3											
4	1	2		3										
5	1	2	3											

UNIT I **9 Hours**

CHARACTERISTICS OF TRANSDUCERS

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, synchros 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.

FOR FURTHER READING

Seismic Sensor - IC temperature sensor- Pneumatic transducer- Flapper-Nozzle sensor - Sensors for environmental monitoring-Sensing environmental pollution-Aerospace sensor- Sensing direction of air flow-Measuring air speed on air craft

Total: 45 Hours

Reference(s)

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Nineteenth edition Dhanpat Rai & Co (P) Ltd, 2012.
2. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, 2009
3. E.O.Doeblin, Measurement Systems: Applications and Design , 6th Edition, Tata McGraw-Hill Book Co., 2012
4. D. V. S. Murthy,Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
5. J. P. Bentley, Principles of Measurement Systems, 4th Edition, Addison Wesley Longman Ltd., UK, 2015

18EI405 LINEAR INTEGRATED CIRCUITS 3 1 0 4

Course Objectives

- To understand the fabrication process of an IC, the characteristics of an Operational amplifier
- To study the characteristics and applications of Op-amp
- To study internal functional blocks and the application of special IC's like Timers, PLL circuits, regulator circuits and converters

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Identify the steps involved in fabrication of an IC and to discuss the characteristics of Op-amp
2. Implement a simple circuit using an Op-amp for given real time application.
3. Design a simple filter circuit using Op-amps and differentiate A/D and D/A conversion techniques.
4. Organize the various special ICs used for field applications.
5. Attribute the factors involved in various types of regulators and amplifiers.

Articulation Matrix

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

UNIT I **9 Hours**

IC FABRICATION

IC classification, fundamentals of monolithic IC technology, epitaxial growth, masking and etching, Diffusion of Impurities and packaging - Realization of simple monolithic ICs

UNIT II **9 Hours**

CHARACTERISTICS OF OP-AMP

Ideal Op-Amp characteristics - Inverting, Non inverting amplifier- voltage series feedback and shunt feedback amplifiers - DC characteristics, AC characteristics: frequency response, frequency compensation and slew rate.

UNIT III **11 Hours**

APPLICATIONS OF OP-AMP

Differential Amplifier, Instrumentation amplifier, Differentiator, Integrator, First order low pass and high pass filters, V/I & I/V converters, comparators, summer, S/H circuit, D/A converter: R-2R ladder and weighted resistor types - A/D converter: Dual slope, successive approximation and flash type.

UNIT IV **8 Hours**

SPECIAL ICS

555 Timer circuit: monostable operation, astable operation and applications - 566-voltage controlled oscillator circuit - 565-phase locked loop circuit functioning and applications.

UNIT V **8 Hours**

WAVEFORM GENERATORS AND APPLICATION ICS

Schmitt trigger, multivibrators, triangular and sine waveform generators, IC voltage regulators: 78XX-Fixed and LM317-adjustable voltage regulators, LM723 general purpose regulators.

FOR FURTHER READING

Second order low pass and high pass filters - clippers, clampers and peak detector, ICL 8038 function generator IC.

Total: 60 Hours

Reference(s)

1. Robert F. Coughlin, Frederick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th Edition, Pearson Education, 2015.
2. Roy Choudhary, Shail B. Jain, Linear Integrated Circuits, New Age Publishing Co, 4th Edition, 2014.
3. Ramakant A. Gayakwad, Op-amps and Linear Integrated Circuits, Prentice Hall, 4th Edition, 2009.
4. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson Education, 4th Edition, 2002.

5. R. M. Marston, Optoelectronics Circuits Manual, Newnes, 2nd Edition, 1999.
6. Anthony Peyton, Vincent Walsh, Analog Electronics with Op-amps: A Source Book of Practical Circuits, Cambridge University Press, 1993

18EI406 COMMUNICATION ENGINEERING 3 0 2 4

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

AMPLITUDE MODULATION

Elements of communication systems - Time and frequency domain - Noise and communications - Amplitude modulation - carrier waves- AM in time domain and frequency domain, Quadrature AM and AM stereo - suppressed carrier AM - AM Transmitters - AM Receivers.

UNIT II **9 Hours**

ANGLE MODULATION

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

UNIT III **9 Hours**

DIGITAL MODULATION

Introduction - Pulse Modulation - Pulse code modulation - Delta Modulation - Line codes - Time division multiplexing - vocoders and Data Compression - Frequency, phase and Quadrature phase shift keying

UNIT IV **9 Hours**

DATA TRANSMISSION AND MODEMS

Data coding - Asynchronous Transmission - Synchronous Transmission - Error detection and Correction - Data compression and encryption - Telephone Modems - Modem to computer connections - Cable Modems and Digital subscriber Lines

UNIT V **9 Hours**

FIBER OPTIC SYSTEMS

Basic fiber optic systems - repeaters and optical amplifiers - wavelength division multiplexing - submarine cables - SONET - Fiber in local area networks - local telephone applications - cable television applications - experimental techniques - optical time-domain reflectometry

FOR FURTHER READING

Local area networks - wide area networks - satellite communication - cellular communication

1 **6 Hours**

EXPERIMENT 1

Amplitude Modulation and Demodulation

2 **6 Hours**

EXPERIMENT 2

Frequency Modulation and Demodulation

3 **6 Hours**

EXPERIMENT 3

Phase Modulation and Demodulation

4 **6 Hours**

EXPERIMENT 4

Pulse Amplitude Modulation and Demodulation

5 **6 Hours**

EXPERIMENT 5

Digital Modulation: ASK, FSK, PSK, QPSK

Total: 75 Hours

Reference(s)

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

18EI407 DIGITAL LOGIC CIRCUITS AND LINEAR INTEGRATED CIRCUITS LABORATORY

0 0 2 1

Course Objectives

- To design and verify various digital logic circuits
- To understand the characteristics and applications of op-amp
- To design the application oriented experiments based on IC 741 and IC 555

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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.
e. 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.
k. 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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Demonstrate the working of computational circuits using logic gates
2. Implement the sequential logic circuits, flip flops and shift registers
3. Implement the monostable and astable multivibrators using NE/SE 555
4. Construct the differentiator, Integrator and converter circuits using Op-Amp
5. Design ADC and DAC circuits using Op-Amp

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Design and Implementation of Full Adder and Full Subtractor Circuits

2 **3 Hours**

EXPERIMENT 2

Realize the Code converters - Gray to Binary, Binary to Gray code, Parity generator and Parity Checker using Logic Gates

3 **3 Hours**

EXPERIMENT 3

Implementation of 4:1 Multiplexer,1:4 De-multiplexer,4:2 Encoder and 2:4 Decoder

4 **3 Hours**

EXPERIMENT 4

Verification of Functional Tables of RS, JK, T and D flip-flops using ICs

5 **3 Hours**

EXPERIMENT 5

Design and implementation of 4-bit Shift Registers in SISO, SIPO, PISO, PIPO modes using suitable ICs

6 **3 Hours**

EXPERIMENT 6

Application of Op-Amp (Inverting, Non-Inverting amplifier, Integrator and Differentiator)

7 **3 Hours**

EXPERIMENT 7

Design and implementation of V to I and I to V converter.

8 **3 Hours**

EXPERIMENT 8

Design of Astable and Mono-stable Multi-vibrator using NE/SE 555 Timer

9 **3 Hours**

EXPERIMENT 9

Design of 2 bit Analog to Digital Converter

10 **3 Hours**

EXPERIMENT 10

Design of 4 bit Digital to Analog Converter

Total: 30 Hours

18EI408 SENSORS AND TRANSDUCER LABORATORY **0 0 2 1**

Course Objectives

- To apply the concepts of transduction, characteristics and response of transducers
- To implement transduction principles and observe the characteristics of various electrical transducers
- To resolve the characteristics of photoelectric and hall effect transducers.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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. Demonstrate a resistive transducer for the measurement of displacement and force
2. Implement the signal conditioning unit for resistance thermometer and linearization of thermistor
3. Attribute the input and output parameters of inductive and capacitive transducers
4. Design the signal conditioning circuit for RTD and linearization circuit of thermistor
5. Organize various factors involved in the measurement of light intensity and speed using optical transducer

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	1	2	3											
4	1			3										
5	1	2												

1 **4 Hours**

EXPERIMENT 1

Measurement of linear displacement and Pressure using inductive transducer

2 **3 Hours**

EXPERIMENT 2

Design of signal conditioning circuit for resistance thermometer

3 **3 Hours**

EXPERIMENT 3

Measurement of magnetic field using Hall Effect transducer

4 **2 Hours**

EXPERIMENT 4

Liquid level measurement using capacitive transducer.

5 **4 Hours**

EXPERIMENT 5

Measurement of light intensity using optical transducers

6 **3 Hours**

EXPERIMENT 6

Design of linearization circuit for thermistor

7 **2 Hours**

EXPERIMENT 7

Vibration measurement using Piezo electric accelerometer

8 **3 Hours**

EXPERIMENT 8

Measurement of force using strain gauge and load cell.

9 **4 Hours**

EXPERIMENT 9

Measurement of linear and angular displacement using resistive transducer.

10 **2 Hours**

EXPERIMENT 10

Measurement of speed using digital shaft angle encoder

Total: 30 Hours

18HS001 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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. 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 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							
4	1													
5	2													

UNIT I **6 Hours**

NATURAL RESOURCES

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

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

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

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

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

FOR FURTHER READING

Human rights:Biomedical waste -Identification of adulterants in food materials

Total: 30 Hours

Reference(s)

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

18GE401 SOFT SKILLS-BUSINESS ENGLISH 0 0 2 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

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

j. 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, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

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

UNIT I **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information - Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 30 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

21EI501 PROCESS CONTROL 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Compute the mathematical model for a physical process by using mass and energy balance equations
2. Apply suitable control mode for different applications
3. Analyze the various control schemes and obtain optimum controller settings using tuning methods
4. Identify the suitable final control elements for a closed loop systems
5. Apply complex control schemes for various applications and develop the P&ID structure for level and flow control loops

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

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

UNIT II **11 Hours**

CONTROLLER CHARACTERISTICS

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

UNIT III **10 Hours**

TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL

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

UNIT IV **7 Hours**

FINAL CONTROL ELEMENT

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

UNIT V **8 Hours**

SELECTED UNIT OPERATIONS

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

FOR FURTHER READING

Internet based ON/OFF controller - Simulation using virtual instrumentation: Temperature control - Level Control - Flow control.

Total: 60 Hours

Reference(s)

1. Curtis D. Johnson, Process Control Instrumentation technology, Pearson new international edition 2013.
2. George Stephanopoulos, Chemical Process Control, PHI learning Pvt. Ltd., New Delhi, 2012
3. D.R. Coughanowr, Steven E LeBlanc, Process Systems Analysis and Control, McGraw Hill,Singapore, 3rd Edition, 2009.
4. B. Wayne Bequette, Process Control: modelling, Design, and simulation, PHI learning Pvt. Ltd., New Delhi, 2010.
5. Jonathan Love Process Automation Handbook: A Guide to Theory and Practice,Springer,2010.
6. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 30th reprint 2010.

21EI502 INDUSTRIAL INSTRUMENTATION -I 3 0 0 3

Course Objectives

- To provide exposure on various measuring techniques acceleration, vibration, torque, force and density
- To learn the working and application of different types of high pressure and vacuum transducers
- To analyze the various types of temperature transducers

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Examine the construction and applications of Linear and Angular displacement and Velocity transducers.
2. Outline the characteristics and applications of acceleration, vibration, torque, force and density transducers.
3. Organize the characteristics of pressure measurement transducers and select suitable method for a specified application.
4. Select the suitable temperature measuring Instruments for a given application.
5. Examine contact and non-contact type temperature measurement schemes and select an appropriate one for specified application

Articulation Matrix

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

UNIT I **9 Hours**

MEASUREMENT OF LINEAR AND ANGULAR DISPLACEMENT AND VELOCITY

Linear displacement: Linear potentiometer, Single-Coil Linear Variable-Reluctance Sensor, Variable-Differential Reluctance Sensor, LVDT, Eddy Current - Angular displacement: Angular potentiometer, Variable-Reluctance Tachogenerators, Synchros, RVDT - Linear velocity: LVDT, seismic Instrument, Doppler Shift Angular velocity: Electrical (dc and ac) Tachometer Generator, Rotating Magnet, Optical Sensors, Hall Effect/Wiegand Effect, Gyroscopes

UNIT II **9 Hours**

MEASUREMENT OF ACCELERATION, VIBRATION, TORQUE, FORCE AND DENSITY

Accelerometers and Vibrometer: Piezoelectric, Piezoresistive, Differential-Capacitance, Strain-Gage and Seismic types - Force: Measurement principle, Load cell- sensing elements-stain gauge and Piezoelectric - Torque: Rotating, Magnetostrictive and Angular Displacement type transducers - Densitometers: Displacement and float type, Hydrometers, Hydrostatic and Vibrating or Coriolis types

UNIT III **9 Hours**

PRESSURE MEASUREMENT

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

UNIT IV **9 Hours**

TEMPERATURE MEASUREMENT I

Definitions and standards : techniques and classifications - bimetallic thermometers, different types of filled in system thermometer - Resistance Temperature Detector (RDT) - Industrial RTD construction requirements - characteristics - signal conditioning - Two-wire, three-wire and four-wire RTDs - 2 wire and 4 wire transmitters -IC temperature sensor - thermistor - Characteristics, measurement methods linearization, thermowell .

UNIT V **9 Hours**

TEMPERATURE MEASUREMENT II

Thermocouples - laws of intermediate temperatures and metals - types of thermocouple - cold junction compensation thermocouple construction - thermocouple output to temperature conversion - Radiation and Infrared Pyrometers: Theoretical relationships- total, narrow band, ratio, optical and IR pyrometers - detectors.

FOR FURTHER READING

Ultrasonic thermometers, Johnson noise thermometer, fluidic sensors, spectroscopic temperature measurements, thermograph, temperature switches and thermostats.

Total: 45 Hours

Reference(s)

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

21EI503 EMBEDDED SYSTEM 3 1 0 4

Course Objectives

- To provide in depth knowledge about embedded processor, its hardware and software
- To understand the embedded system design and their operating system
- To apply knowledge of embedded processor architecture in various applications

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. To illustrate the architecture and the functionality of PIC Microcontroller.
2. To Summaries the architecture and the functionality of ARM Microprocessor.
3. To outline the basic concepts of embedded system and interfacing input and output peripherals.
4. To design a real time application for various domains using embedded system.
5. To Implement a real time application in an embedded systems.

Articulation Matrix

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

UNIT I **9 Hours**

PIC MICROCONTROLLER

CPU Architecture and instruction sets: Hardware architecture and pipelining - program memory consideration - register file structure and addressing modes - CISC vs. RISC - CPU Register - Timer and counter - Interrupt - A/D convertors - UART

UNIT II **9 Hours**

ARM MICROCONTROLLER

LPC2148 ARM 7 microcontroller - Features of LPC2148 - Pin diagram of LPC2148 - Architectural overview - Abstraction in hardware design - Memory Interface, Bus Cycle types, Register set, Operational Modes - 3 and 5 Stage Pipeline ARM Organization - ARM Instruction Execution and Implementation.

UNIT III **12 Hours**

EMBEDDED SYSTEM AND I/O INTERFACING AND COMMUNICATION PROTOCOL

Introduction to embedded system - embedded system architecture - classifications of embedded systems - design challenges in embedded systems - processor technology. Interfacing and Communication Protocols Interfacing of LEDs, 7segment LEDs - LCD and Keypad interfacing - A/D converters, stepper motors - SPI - UART - I2C - Bluetooth - Zig-Bee - LoRa.

UNIT IV **8 Hours**

REAL TIME OPERATING SYSTEM

Architecture of the Kernel- Multitasking- Tasks- Context Switches- Kernels- Schedulers- Priorities - Deadlock - Event Flags- Interrupts - Interrupt Latency-Interrupt Response- Interrupt Recovery - Message Mailboxes- Message Queues - RTOS:Ã‚µCOS

UNIT V **7 Hours**

REAL TIME EMBEDDED SYSTEM

Digital camera -Washing Machine -Automated teller machine - Vending machine -Personal Digital Assistant - Industrial Robots- Food processing industry.

FOR FURTHER READING

Introduction Artificial Intelligence, Internet of Things, Cloud Computing, Advanced embedded systems

Total: 60 Hours

Reference(s)

1. Frank Vahid and Tony Givargis "Embedded System Design: A Unified Hardware/Software Approach", Department of Computer Science and Engineering University of California, Riverside, CA 92521, Draft version, Fall 1999
2. Rajkamal, "Embedded system-Architecture, Programming and Design", Tata McGraw-Hill Education Pvt. Ltd, 2011.
3. Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson, 2013.
4. Peckol, "Embedded system Design", John Wiley &Sons, 2010.
5. http://scp.s-scptuj.mb.edus.s
6. Steve Furber, ARM System on Chip Architecture, Addison Wesley Professional, 2000.

21EI504 DIGITAL SIGNAL PROCESSING 3 1 0 4

Course Objectives

- To execute the Z transform and Discrete Fourier Transform (DFT) for a given signal / system.
- To design the digital filters and realize the digital filters by different structures.
- To understand the architecture and features of the digital signal processor.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

d. 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.

e. 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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Apply the mathematical concepts to investigate the discrete time signals and systems.
2. Apply the Z transform and Discrete Fourier Transform for a given signal / system.
3. Design the digital filters and analyze the amplitude and phase response of FIR filters.
4. Implement and analyze issues of discrete time systems.
5. Develop simple programs in ADSP for specific applications

Articulation Matrix

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

UNIT I **8 Hours**

SIGNALS AND SYSTEMS

Basic elements of digital signal processing - concepts of frequency in analog and digital signals - classification of discrete time signals - classification of discrete time systems - mathematical representation of signals - sampling and reconstruction of continuous time signals.

UNIT II **11 Hours**

TRANSFORMATIONS

Z transform - properties - inverse Z transform - solution of difference equations by Z transform; Discrete Fourier Transform (DFT) - properties - Efficient computation of DFT: radix-2 Fast Fourier Transform (FFT) algorithms in Decimation in Time (DIT) & Decimation in Frequency (DIF) - correlation techniques.

UNIT III **11 Hours**

DIGITAL FILTER DESIGN

Finite Impulse Response (FIR) design: Amplitude and phase responses of FIR filter - Linear phase characteristics - Need and choice of windows - Windowing Techniques: Rectangular, Hamming and Hanning; Infinite Impulse Response (IIR) design: Design of digital low pass Filter - Butterworth, Chebyshev filter - impulse invariant and bilinear transformation - Frequency transformation.

UNIT IV **8 Hours**

IMPLEMENTATION OF DISCRETE TIME SYSTEMS

Structure for FIR systems: Direct, cascade, frequency sampling, Lattice; Structure for IIR System: Direct, cascade and parallel; Finite word Length Effects: Representation of numbers - Quantization of filter coefficients - round-off effects in digital filters.

UNIT V **7 Hours**

DIGITAL SIGNAL PROCESSORS

Introduction to DSPs - Architecture, Assembly Language Instructions, Instruction Pipelining and simple programs in ADSP.

FOR FURTHER READING

DFT based Dual-Tone Multi-Frequency (DTMF) detection algorithm - analysis of speech signals using STFT (Short-Time Fourier Transform) - Power Spectrum estimation using an AR model by FIR / IIR digital filter - Time domain operations in Musical Sound Processing by FIR / IIR digital filter.

Total: 60 Hours

Reference(s)

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing Principles, Algorithms and Applications, PearsonEducation, New Delhi, 2013.
2. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Discrete - Time Signal Processing, Pearson Education, New Delhi, 2013.
3. S. Salivahanan, C. Gnanapriya, Digital Signal Processing, Tata McGraw Hill Education Private Ltd, New Delhi, 2010.
4. P. Ramesh Babu, Digital Signal Processing, Scitech Publications (India) Pvt Limited, 2012.
5. S. K. Mitra, Digital Signal Processing - A Computer Based Approach, Tata McGraw Hill, New Delhi, 2012
6. B.Venkataramani, M. Bhaskar, Digital Signal Processors, Architecture, Programming and Applications, Tata McGraw Hill, New Delhi, 2013.
7. Website:http: //www.analog.com/en/products/processors-dsp/adsp-21xx-processors/adsp-21992.html#product-overview

21EI507 PROCESS CONTROL LABORATORY 0 0 2 1

Course Objectives

- To acquire knowledge about the functionality of field instruments and controllers.
- To gain the programming knowledge in virtual instrumentation for process control.
- To design and implementation of controllers for different processes.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Demonstrate final control element, converter and transmitter in real time.
2. Compute an open loop response for a level control process.
3. Determine a closed loop response for temperature, pressure and flow process station.
4. Design ON/OFF controller for a given system.
5. Attribute PID tuning parameters and implement advanced control schemes for level and pressure process.

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Open loop response of interacting and non interacting level process.

2 **3 Hours**

EXPERIMENT 2

Analyze the response of different types of control valves.

3 **3 Hours**

EXPERIMENT 3

Tuning of PID controller for first and second order system.

4 **3 Hours**

EXPERIMENT 4

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

5 **3 Hours**

EXPERIMENT 5

Closed loop control of temperature process station.

6 **3 Hours**

EXPERIMENT 6

Closed loop control of pressure process station.

7 **3 Hours**

EXPERIMENT 7

Design of on/off controller for air flow temperature process station.

8 **3 Hours**

EXPERIMENT 8

Implementation of cascade control scheme for level process.

9 **3 Hours**

EXPERIMENT 9

Implementation of single loop PID controller for a pressure process station.

10 **3 Hours**

EXPERIMENT 10

Piping and Instrumentation Diagram for flow or level process using Prodok Software or Smartdraw.

Total: 30 Hours

21EI508 EMBEDDED SYSTEM LABORATORY 0 0 2 1

Course Objectives

- The students will be able to perform systematic analysis using microcontroller
- The students will be able to demonstrate the task management system with delay using microcontroller
- The students will be able to do multitasking in RTOS using microcontroller
- The students will be able to establish the real-world communication to transfer data over application layer using communication devices

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
k. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Summaries the hardware design and development tools of PIC and ARM microcontroller
2. Attribute the architectural support for high level language and memory hierarchy.
3. Outline microprocessor and microcontroller interfacing with I/O peripherals.
4. Implement a wired and wireless network to transfer data.
5. Design a real time embedded application.

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

1 **3 Hours**

EXPERIMENT 1

Implementation of LED control using switch with PIC Microcontroller

2 **3 Hours**

EXPERIMENT 2

Interface LCD with PIC Microcontroller and display "Hello World"

3 **3 Hours**

EXPERIMENT 3

Interfacing KEYPAD with PIC and display value on serial terminal when a key is pressed using UART

4 **3 Hours**

EXPERIMENT 4

Interfacing 7 segment display with PIC microcontroller

5 **3 Hours**

EXPERIMENT 5

Implementation of task management and delays in uC/OS on ARM (LPC2138)

6 **3 Hours**

EXPERIMENT 6

Implement a program for measuring Temperature with ARM (LPC2138)

7 **3 Hours**

EXPERIMENT 7

Multitasking in uC/OS-II RTOS using minimum 3 tasks on ARM (LPC2138)

8 **3 Hours**

EXPERIMENT 8

Interfacing Zigbee with LPC2138 microcontroller

9 **3 Hours**

EXPERIMENT 9

Interface Bluetooth using ARM (LPC2138) to transfer a data over the range 100 meter

10 **3 Hours**

EXPERIMENT 10

Interface of WiFi module using PIC microcontroller for Transmission and Reception of data.

Total: 30 Hours

21GE501 SOFT SKILLS - APTITUDE I **0 0 2 0**

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

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

1 **2 Hours**

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2 **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations- Concept of percentage values through additions-Fraction to percentage conversion table.

3 **3 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average- Replacement of some of the items.

4 **3 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6 **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7 **2 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9 **2 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

3 1 0 4

21EI601 INDUSTRIAL AUTOMATION

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Formulate PLC Architecture, I/O devices and its programming methodologies.
2. Design PLC, PAC and SCADA programming for given real time applications
3. Formulate various architectures and Execute FBD programming in DCS.
4. Implement various hardware interfacing methods with DCS for real time applications
5. Implement various hardware interfacing methods with HMI for real time applications

Articulation Matrix

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

UNIT I **10 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Evolution of PLCs- Components of PLC - Architecture of PLC - Discrete and analog I/O modules - Programming languages - Ladder diagram - Function block diagram (FBD) - Programming timers and Counters- Instructions in PLC - Program control instructions, math instructions, data manipulation Instructions, sequencer and shift register instructions- PLC Standards IEC 61131-3

UNIT II **8 Hours**

PLC PAC SCADA AND ITS APPLICATIONS

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

UNIT III **8 Hours**

DISTRIBUTED CONTROL SYSTEM

DCS - Various Architectures: Hybrid, Central Computers, Distributed architectures - Comparison - Local control unit Ã¢?? Architectures - Process interfacing issues- Redundant Controller Designs- Process Input/ Output Design Issues.

UNIT IV **10 Hours**

INTERFACES IN DCS

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

UNIT V **9 Hours**

HUMAN MACHINE INTERFACE

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

FOR FURTHER READING

Local Area Network - Wireless communication (Ipv6, Ipv4)- Programmable Automation Controller - CAN bus - Analog I/O configuration in PLC programming, Communication Protocol

Total: 60 Hours

Reference(s)

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

21EI602 INDUSTRIAL INSTRUMENTATION-II 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Examine the design, construction and features of fixed and variable head type flowmeters
2. Analyze the characteristics of mechanical flow meters
3. Analyze the characteristics of electrical type flow meters and select suitable flow meter for a specified flow application
4. Select the suitable level measuring instruments for a given applications
5. Examine various methods of Humidity, Moisture and Viscosity measurement.

Articulation Matrix

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

UNIT I **8 Hours**

FLOW METERS I

Head type flow meters: Theory and characteristics, Flow rate based on Bernoulli's equation, Orifice: types and Location of pressure taps, limitations - venturi tube - flow nozzle - dall tube - pitot tube - installation of head flow meters.

UNIT II **9 Hours**

FLOW METERS II

Positive displacement flow meters : constructional details and theory of reciprocating piston, oval gear and helix type flow meters - inferential meter - turbine flow meter - nutating disc - rotameter - theory and installation - angular momentum mass flow meter - coriolis mass flow meters - thermal mass flow meters.

UNIT III **8 Hours**

FLOW METERS III

Principle and constructional details of electromagnetic flow meter - different types of excitation schemes used - different types of ultrasonic flow meters - laser doppler anemometer - vortex shedding flow meter - target flow meter - solid flow rate measurement - guidelines for selection of flow meter.

UNIT IV **10 Hours**

LEVEL MEASUREMENT

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

UNIT V **10 Hours**

MEASUREMENT OF HUMIDITY, MOISTURE AND VISCOSITY

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

FOR FURTHER READING

Case studies on industrial measurement - data sheet for industrial sensors/transducers

Total: 45 Hours

Reference(s)

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

21EI603 INTERNET OF THINGS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Explain the characteristics in internet of things
2. Explain the various design levels in internet of things
3. Execute on connected devices, domains and various protocol standards
4. Select the suitable protocols for the IoT level for a given applications
5. Demonstrate the working and challenges of IOT on various domain specific applications

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO INTERNET OF THINGS

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

UNIT II **9 Hours**

DESIGN OF INTERNET OF THINGS

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

UNIT III **9 Hours**

DESIGNING CONNECTED DEVICES

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

UNIT IV **9 Hours**

VARIOUS PROTOCOL STANDARDS AS ENABLERS OF IOT

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

UNIT V **9 Hours**

DOMAIN SPECIFIC IOT AND THEIR CHALLENGES

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

FOR FURTHER READING

Application of Internet of Things in Industries

Total: 45 Hours

Reference(s)

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

21EI607 INDUSTRIAL INSTRUMENTATION LABORATORY

0 0 2 1

Course Objectives

- To strengthen knowledge in measurements of flow, torque and humidity using various transducers
- To calibrate the pressure transducers using different standards
- To design of compensation and linearization circuit for temperature transducers

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

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.

d. 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.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Demonstrate the orifice meter, Venturi meter, Mass flow meter, DPT setup for measuring flow rate and Level
2. Compare the pressure gauge and DPT using standard instruments
3. Compare the pressure gauge and DPT using standard instruments
4. Design the linearization and compensation circuit for thermocouple
5. Integrate the field instruments with controller

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Measurement of flow rate using Orifice meter, Venturi meter and mass flow meters

2 **3 Hours**

EXPERIMENT 2

Calibration of pressure gauge using Dead weight tester.

3 **3 Hours**

EXPERIMENT 3

Torque measurement using strain gauge

4 **3 Hours**

EXPERIMENT 4

Interfacing of field instruments with controller.

5 **3 Hours**

EXPERIMENT 5

Measurement of humidity and vacuum

6 **3 Hours**

EXPERIMENT 6

Level measurement using Differential pressure transducers

7 **3 Hours**

EXPERIMENT 7

pH measurement and conductivity measurement.

8 **3 Hours**

EXPERIMENT 8

Design of cold Junction compensation circuit for Thermocouple

9 **3 Hours**

EXPERIMENT 9

Linearization of Thermocouple

10 **3 Hours**

EXPERIMENT 10

Calibration of Differential pressure transducers using HART communicator

Total: 30 Hours

21EI608 INDUSTRIAL AUTOMATION LABORATORY

0 0 2 1

Course Objectives

- To obtain practical knowledge in advanced controllers
- To automate linear and non linear processes
- To design discrete controller for a transfer function model

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

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.

e. 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.

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

n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Develop Ladder Logic Program in PLC (Allen bradly, Delta, Mitsubishi, omran, hornor) for controlling Level, Flow, Temperatur and Pressure at desired set value
2. Develop Ladder Logic Program in PLC (Allen bradly) to automate bottle filling process for beverage industries and to provide solutions for traffic issues
3. Develop Functional Block diagram Program in Honeywell-DCS for controlling Level, Flow, Temperature and Pressure at desired set value by implementing cascade loop structure.
4. Interface and Configure DCS for Sequence control and Interlocking process for real time applications
5. Interface and Configure the AC and DC Motors using HMI

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Control of Level and flow using PLC

2 **3 Hours**

EXPERIMENT 2

Control of automatic bottle filling system using PLC.

3 **3 Hours**

EXPERIMENT 3

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

4 **3 Hours**

EXPERIMENT 4

Interfacing of Variable Frequency Drive with PLC

5 **3 Hours**

EXPERIMENT 5

Implementation of PID controller for multi loop process

6 **3 Hours**

EXPERIMENT 6

Control of Pressure and Flow process using DCS

7 **3 Hours**

EXPERIMENT 7
Design of interlock system using DCS

8 **3 Hours**

EXPERIMENT 8
Configuring DCS- System for sequence control

9 **3 Hours**

EXPERIMENT 9
Control of Temperature process using DCS

10 **3 Hours**

EXPERIMENT 10
Interfacing of AC and DC motors using HMI

Total: 30 Hours

21GE601 SOFT SKILLS-APTITUDE II 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)
a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides colored.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

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

1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

4 **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6 **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10 **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11 **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12 **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13 **2 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21HS002 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)

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

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

j. 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	2				
2								3	2	2				
3								3	2	2				
4								3	2	2				
5								3	2	2				

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

1.Importance of Human Values & Ethics in 21st Century
2.Understanding the theory of basic human values and ethics
Openness to change
Self-enhancement
Conservation
Self-transcendence
3. 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. (2011). The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin.
2. Gupta, N. L. (2002). Human Values For The 21St Century. India: Anmol Publications Pvt. Limited.
3. Mishra, A. (2017). Happiness Is All We Want. India: Bloomsbury Publishing.
4. Universal Human Values. (2023). (n.p.): Booksclinic Publishing.
5. A Textbook On Professional Ethics And Human Values. (2007). India: New Age International (P) Limited

21EI702 INDUSTRIAL DATA COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Summarize the basics of Data communications and networks
2. Infer the significance of different industrial networks.
3. Explain the architecture of HART and Field bus protocol.
4. Compare Modbus and Profibus protocols.
5. Analyze the industrial network threats and propose appropriate solutions.

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF DATA COMMUNICATION AND NETWORKS

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

UNIT II **9 Hours**

INDUSTRIAL NETWORKS

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

UNIT III **9 Hours**

HART AND FIELD BUS

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

UNIT IV **9 Hours**

MODBUS AND PROFIBUS

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

UNIT V **9 Hours**

NETWORK SECURITY AND CRYPTOGRAPHY

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

FOR FURTHER READING

HART and smart instrumentation HART protocol,Physical layer, Data link layer and its benefits - Troubleshooting of HART

Total: 45 Hours

Reference(s)

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

21EI707 PROCESS MODELING AND SIMULATION LABORATORY

0 0 2 1

Course Objectives

- To acquire knowledge about the modeling of process plant.
- To gain the programming knowledge in MATLAB for industrial- control applications.
- To analyze various controllers for different systems

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

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.

d. 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.

e. 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.

n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Identify the given system model and simulate its output response using MATLAB
2. Design conventional PID and fuzzy based controller for given system
3. Design Model (IMC and MPC) based controller and Digital controller for given system
4. Identify the DC motor, cruise system model and design suitable controller
5. Design digital controller for industrial storage tank systems

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Simulation of Lumped and Distributed Parameter Systems

2 **3 Hours**

EXPERIMENT 2

System Identification of given systems using Parametric Methods

3 **3 Hours**

EXPERIMENT 3

Design of Digital P I D controller for given process model

4 **3 Hours**

EXPERIMENT 4

Digital controller design using dead-beat and dalhins algorithm

5 **3 Hours**

EXPERIMENT 5

Design of Fuzzy controller for given process

6 **3 Hours**

EXPERIMENT 6

Design of IMC control scheme for given process

7 **3 Hours**

EXPERIMENT 7

Design of MPC controller for given process

8 **3 Hours**

EXPERIMENT 8

Modeling and control of DC motor speed and position

9 **3 Hours**

EXPERIMENT 9

Modeling and control of cruise (vehicle speed) system

10 **3 Hours**

EXPERIMENT 10

Modeling and digital controller design for four tank system

Total: 30 Hours

21EI708 PROJECT WORK I **0 0 6 3**

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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. 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.
k. 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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

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 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

Total: 0 Hours

21EI801 PROJECT WORK II **0 0 18 9**

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)
a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.

e. 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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. 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.
k. 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.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

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

Total: 0 Hours

18EI0XA VIRTUAL INSTRUMENTATION IN INDUSTRIAL AUTOMATION

1 0 0 1

Course Objectives

- To understand the role of LabVIEW in Industries for Instrumentation Engineers

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. To apply virtual instrumentation concepts in industrial automation

Articulation Matrix

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

UNIT I **20 Hours**

LABVIEW

LabVIEW in Advanced Instrument Control and industrial Automation - Role of LabVIEW in Industry 4.0 - LabVIEW Environment - Decision making and looping architecture - Hands on Virtual Instrument Development - Hand-on Data Acquisition, Analysis and File Handling operations - Data logging methods - Hands on PID based Control Application development using LabVIEW

Total: 20 Hours

Reference(s)

1. Instrumentation systems - ISA 5.1, International Society of Automation
2. Industry 4.0 - https://en.wikipedia.org/wiki/Industry_4.0
3. Virtual Instrumentation Using LabVIEW - Sanjay Gupta, Joseph John https://books.google.co.in/books/about/Virtual_Instrumentation_Using_Labview_2E.html?id=en1GKs2huTcC&redir_esc=y
4. http://sine.ni.com/cs/app/doc/p/id/cs-17475
5. http://sine.ni.com/cs/app/doc/p/id/cs-13566

18EI0XB CALIBRATION TECHNIQUES 1 0 0 1

Course Objectives

- To impart necessary knowledge in calibration techniques and its applications

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Understand the calibration techniques in field instruments.

Articulation Matrix

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

UNIT I **15 Hours**

Introduction - Industry Protection Standards - Temperature Calibration - Resistance Temperature Detectors (RTD) - Thermocouple - Thermostat - Calibration ofPressure Transmitter - Pressure switches with Documenting Process Calibrators (DPC)- Calibration of Control Valve Positioner - Loop Calibration and Maintenance- Calibrating Highway Addressable Remote Transducer (HART) communication protocol based transmitters- Calibration of non-contact type transmitters

Total: 15 Hours

Reference(s)

1. Mike Cable, "Calibration - A Technician"s Guide, The Instrumentation, Systems and Automation Society, 2014.

18EI0XC FACTORY AUTOMATION 1 0 0 1

Course Objectives

- To understand the function of packaging machine.
- To introduce elements of automation - Sensing, Actuation and Control.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
e. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. To understand the function of packaging machine.
2. To introduce elements of automation - Sensing, Actuation and Control.

Articulation Matrix

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

UNIT I **20 Hours**

Introduction to Packaging Machinery - Need for Packaging Machines - Types of Packaging Machines - Basic components of a Linear Weighing Machine - Hook-up Diagram of a Linear Weighing Machine - Selection of Load Cell and its Interface circuitry (Pre-amp, ADC) -Introduction to Electromagnetic Vibrator and its Control (TRIAC, Firing Angle Control) PLC or Microcontroller based Control - Control Algorithm Basics and its Implementation HMI, Recipe settings and Calibration - Customer Requirements : Speed, Accuracy, Reliability, Repeatability

Total: 20 Hours

Reference(s)

1. George Crispe Whiteley,The Law Relating to Weights, Measures, and Weighing Machines,Knight and Company,2011.
2. Shimon Y. Nof,Springer Handbook of Automation,Springer Science & Business Media,2010

18EI0XD INDUSTRIAL SAFETY STANDARDS FOR INSTRUMENTATION PRODUCTS

1 0 0 1

Course Objectives

- To acquire basic concepts of instrumentation in food, petro chemical and continuous process industries.
- To provide an awareness on the different safety standards.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
e. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. To acquire basic concepts of instrumentation in food, petro chemical and continuous process
2. To provide an awareness on the different safety standards.

Articulation Matrix

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

UNIT I **20 Hours**

LABVIEW

Introduction to instrumentation involved in food industry / petrochemical industry /continuous process industry - Different standard requirements for safety products - Hazardous environment and instrumentation - Protection methods for instrumentation electronics - Wiring and installation best practices

Total: 20 Hours

Reference(s)

1. Nicholas P. Cheremisinoff, Practical Guide To Industrial Safety, Marcel Dekker, Inc, 2006
2. Walt Boyes, Instrumentation Reference Book, Butterworth-Heinemann, 2008http://sine.ni.com/cs/app/doc/p/id/cs-13566

21EI0XE PIPING AND INSTRUMENTATION 1 0 0 1

Course Objectives:

- To acquire basic knowledge in piping and instrumentation diagram
- To enable students to design piping and instrumentation diagram for different application

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

Course Outcomes (COs)

1. Summarize the concepts piping and instrumentation
2. Design piping and instrumentation for given application

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	2	2				2						2	

UNIT I **15 Hours**

Symbols and layout – loop diagram – tagging conventions – line and function symbol- equipment representation - Pump selection – pressure drop in pipelines – power requirements for pumping liquids – characteristics curves for centrifugal pumps – system curve – net positive suction head – pump and other shaft seals - Wall thickness: pipe schedule – pipe supports – pipe fittings – pipe stressing – layout and design – pipe size selection – examples: Basic neutralizer control system, basic column control, batch reactor control system, continuous feed and recycle tank - Process design of fluid moving devices – flow meters – process design of orifice meter – process design of rotameter (P&I) – two phase flow – troubleshooting of fluid flow system – Motor control Standards (included)

Total: 15 Hours

Reference(s)

1. Terrence L. Blevins, Mark Nixon, Control Loop Foundation: Batch and Continuous Processes, ISA, 2017. 2. R. K. Sinnott, John Metcalfe Coulson, John Francis Richardson, Chemical engineering design, Elsevier Butterworth-Heinemann, 2014 3. S.B Thakore, B.I Bhatt, Introduction to Process Engineering and Design,Tata McGraw-Hill, 2007.
2. R. K. Sinnott, John Metcalfe Coulson, John Francis Richardson, Chemical engineering design, Elsevier Butterworth-Heinemann, 2014.
3. S.B Thakore, B.I Bhatt, Introduction to Process Engineering and Design,Tata McGraw-Hill, 2007.

18EI0XF VFD BASED INDUSTRIAL APPLICATIONS 1 0 0 1

Course Objectives

- To know the working and control schemes of VFD and its applications

Programme Outcomes (POs)

f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

3. Learn the basic concepts and control of VFD in various applications.

Articulation Matrix

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

UNIT I **20 Hours**

Basic terminology associated with motors and Variable speed drives -variable speed drives - Different types of Drives- Variable Frequency and Variable Voltage drives - Different control modes of VFDs - Discrete and Continuous control schemes - Effect of long-distance cables on VFD's Different Types of braking - Selection of VFDs based on application.

Total: 20 Hours

Reference(s)

1. Insti, E. &. t. H., Variable Speed Pumping: A Guide to Successful Applications, United Kingdom: Elsevier Science, 2004.
2. Anderson, G. D., Variable Frequency Drives: Installation & Troubleshooting!. (n.p.): Create space Independent Pub, 2013.
3. ABB drives, Guide to Variable Speed Drives - Technical Guide No. 4., 2012.
4. Vinod Kumar, Ranjan Kumar Behera, Dheeraj Joshi, Ramesh Bansal :Power Electronics, Drives, and Advanced Applications,CRC Press · 2020
   Jan A. Melkebeek, Electrical Machines and Drives,Springer International Publishing,2018.

21EI0XG SAFETY INSTRUMENT SYSTEM DESIGN 1 0 0 1

Course Objectives:

- To acquire basic knowledge in understanding the piping and instrumentation diagrams.
- To understand the standards used in industry for different applications.

Programme Outcomes (POs)

f. 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.
g. 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. To acquire basic knowledge in understanding the piping and instrumentation diagrams.
2. To understand the standards used in industry for different applications.

Articulation Matrix

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

UNIT I **20 Hours**

P&ID – Understanding of P&ID, Design of Interlocks (5 Hours)

a) Introduction to ISA 5.1
b) Understanding and selection of various symbols
c) Instrumentation as per API 554
d) Design and Development of interlocks

Instrumentation Design Specification (Selection Procedure) – (4.5 Hours)

a) Instruments specification for pressure
b) Instruments specification for level
c) Instruments specification for temperature
d) Instruments specification for flow
e) Selection of various Instruments and sizing standards

Instrument Detailing – Index, BOQ, Datasheet and Hook-up drawing preparation (4.5 Hours)

a) Preparation of Instrument Index sheet
b) Instrument Installation BOQ
c) Preparation of Instrument datasheet
d) Preparation of Instrument Hook-up

Diagram Control System Integration Design – Cable schedule, Loop schematics, JB Detailing, PLC Designing, Safety Instrumentation system (4 Hours)

a) Field – Control system communication protocols and integration methods
b) Cable scheduling
c) Preparation of Loop schematics
d) Preparation of JB Details
e) Control system architecture designing
f) Safety Instrumentation system design

Installation, Testing and Commissioning (2 Hours)

a) Instrumentation Installation standards and calibration methods
b) Instrument site testing and loop checking standards
c) System commissioning and stabilization

Total: 20 Hours

Reference(s)

1. Instrumentation symbols and identification - ISA 5.1, International Society of Automation
2. Process Measurement Instrumentation - API RP 551, International Society of Automation

21EI001 / 21EIM01 SMART SENSORS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Summarize 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 smart sensor
4. Analyze and select the suitable smart sensor for different industrial applications
5. Integrate 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	1	2	1	1									1	
2	1	2	3	2									1	
3	1	2	3	1									1	
4	1	2	3	2									3	
5	1	2	3	1									3	

UNIT I **8 Hours**

SENSORS & TRANSDUCER

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 and Fields; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Light;

UNIT III **9 Hours**

INTELLIGENT SENSORS

General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors.

UNIT IV **10 Hours**

OVERVIEW OF FLEXIBLE ELECTRONICS TECHNOLOGY

History of flexible electronics - Materials for flexible electronics: degrees of flexibility, substrates, backplane electronics, front plane technologies, encapsulation.

UNIT V **10 Hours**

WEARABLE HAPTICS

World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunities - Future of wearables.

FOR FURTHER READING

Sensor fabrication, Applications of Smart Sensors

Total: 45 Hours

Reference(s)

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

21EI002 / 21EIM02 IOT PROTOCOLS AND INDUSTRIAL SENSORS

3 0 0 3

Course Objectives

- To impart knowledge on the infrastructure, sensor technologies and networking technologies of Internet of Things (IoT).
- To analyze, design and develop IoT solutions.
- To explore the entrepreneurial aspect of the Internet of Things
- To apply the concept of Internet of Things in the real world scenarios.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.

d. 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.

e. 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 main components of Internet of Things
2. Program the sensors and controller as part of IoT
3. Assess different Internet of Things technologies and their applications.
4. To learn basic circuits, sensors and interfacing, data conversion process and shield libraries to interface with the real world
5. To understand various challenges in designing IoT devices

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

UNIT I **9 Hours**

IOT FUNDAMENTALS

Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security.

UNIT II **9 Hours**

IOT REFERENCE ARCHITURE AND SOFTWARE DESIGN

Control Units – Communication modules – Bluetooth – Zigbee – Wifi – GPS- IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP etc..), MQTT, Wired Communication, Power Sources;

UNIT III **10 Hours**

TECHNOLOGIES BEHIND IOT

Four pillars of IoT paradigm, - RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IoT Enabling Technologies - Big Data Analytics, Cloud Computing, Embedded Systems.

UNIT IV **8 Hours**

RESOURCE MANAGEMENT IN IOT

Clustering, Clustering for Scalability, Clustering for routing, Clustering Protocols for IoT.

UNIT V **9 Hours**

APPLICATIONS OF IOT

Business models for IoT, Green energy buildings and infrastructure, Smart farming, Smart retailing and Smart fleet management.

FOR FURTHER READING

Recent trends in IoT

Total: 45 Hours

Reference(s)

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 1st edition, Wiley Publications, 2019.
2. Vermesan, Ovidiu, and Peter Friess, eds. Internet of things-from research and innovation to market deployment, 1st edition, Aalborg: River publishers, 2014.
3. Tsiatsis, Vlasios, Tsiatsis, Vlasios, Stamatis Karnouskos, Jan Holler, David Boyle, and Catherine Mulligan, Internet of Things: technologies and applications for a new age of intelligence, 2nd edition, Academic Press, 2018.
4. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer,2016.

21EI003 / 21EIM03 IOT SYSTEM DESIGN 3 0 0 3

Course Objectives

- To impart knowledge about various sensors in multidisciplinary engineering domain
- To analyze, design and develop IoT solutions.
- To explore the entrepreneurial aspect of the Internet of Things

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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.
e. 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.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Summarize the characteristics of IoT Systems.
2. Compare the standards of IoT Protocols.
3. Construct the IoT Architecture and sequence the IoT devices
4. Analyze and select the suitable Web of Things Architecture
5. Integrate the modern technologies to design IoT systems for various applications.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO IOT SYSTEMS

Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.

UNIT II **8 Hours**

IOT PROTOCOLS

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols;

UNIT III **9 Hours**

IOT ARCHITECTURE

IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoT: An Open source IoT stack - Overview- IoT stack architecture- Resource model and Abstraction.

UNIT IV **10 Hours**

WEB OF THINGS

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT.

UNIT V **10 Hours**

IOT APPLICATIONS

IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications.

FOR FURTHER READING

Study of existing IoT platforms /middleware, IoT- A, Hydra

Total: 45 Hours

Reference(s)

1. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press,2012
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
3. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

21EI004 / 21EIM04 WIRELESS SENSOR NETWORK DESIGN 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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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. Summarize the characteristics of Wireless Sensor Networks.
2. Compare the characteristics and working principles of Adhoc Sensor Networks
3. Construct Wireless Sensor Network using MAC Protocols
4. Analyze and select the suitable Routing Protocols for industrial applications
5. Integrate the modern technologies for energy efficient wireless sensor networks.

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

UNIT I **8 Hours**

INTRODUCTION TO WIRELESS SENSOR NETWORK

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques.

UNIT II **8 Hours**

ADHOC SENSOR NETWORK

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network; Ad-hoc Security; Cross Layer Design.

UNIT III **9 Hours**

MAC PROTOCOLS

Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network.

UNIT IV **10 Hours**

ROUTING PROTOCOLS

Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

UNIT V **10 Hours**

QoS and ENERGY MANAGEMENT

Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power.

FOR FURTHER READING

System power management schemes.

Total: 45 Hours

Reference(s)

1. Jochen Schiller, "Mobile Communications", Pearson Education, 2nd Edition, 2003.
2. William Stallings, "Wireless Communications and Networks ", Pearson Education – 2004
3. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.

21EI005 / 21EIM05 INDUSTRIAL IoT AND INDUSTRY 4.0 3 0 0 3

Course Objectives

- To impart knowledge on the infrastructure, sensor technologies and networking technologies of Industrial Internet of Things (IIoT).
- To analyze, design and develop IIoT solutions.
- To explore the entrepreneurial aspect of the Industrial Internet of Things

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits.

Course Outcomes (COs)

1. Summarize the characteristics of IIoT systems.
2. Compare the characteristics of Industry 4.0 and Cyber Physical Systems.
3. Construct smart energy sources using Industry 4.0.
4. Analyze and select the suitable smart grid architecture for industrial applications.
5. Integrate the modern technologies for smart applications.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO IIOT

Introduction, Historical Context, General framework, Application areas, Dissemination of Industry 4.0 and the disciplines that contribute to its development, Artificial intelligence, The Internet of Things and Industrial Internet of Things.

UNIT II **8 Hours**

INDUSTRY 4.0 AND CYBERPHYSICAL SYSTEMS

Introduction to Cyber Physical Systems (CPS), Architecture of CPS- Components, Data science and technology for CPS, Emerging applications in CPS in different fields;

UNIT III **9 Hours**

SMART ENERGY SOURCES

Energy Storage for Mitigating the Variability of Renewable Electricity Sources-Types of electric energy storage.

UNIT IV **10 Hours**

SMART GRID

Smart grid definition and development Smart Grid, Understanding the Smart Grid, Smart grid solutions, Design challenges of smart grid and Industry 4.0.

UNIT V **10 Hours**

SMART APPLICATIONS

Understanding Smart Appliances -Smart Operation-Smart Monitoring-Smart Energy Savings-Smart Maintenance.

FOR FURTHER READING

Case study-Smart Cars, Self-Driving Cars

Total: 45 Hours

Reference(s)

1. 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.
2. 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
3. Hossam A. Gabbar, - Smart Energy Grid Engineering‖, Academic Press, 2017, ISBN 9780-12-805343-0.
4. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems Taylor and Francis, 2020.

21EI006 / 21EIM06 DATA ANALYTICS FOR IOT 3 0 0 3

Course Objectives

- To analyze, design and develop IoT solutions using Data Analytics.
- To explore the entrepreneurial aspect of the Internet of Things
- To apply the concept of Internet of Things in the real world scenarios using Data Analytics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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. Understand the fundamentals of IoT Analytics and Challenges
2. Understand and analyze IoT Devices and Networking Protocols.
3. Apply IoT Analytics for the Cloud.
4. Understand exploring and visualizing data
5. Apply analytics for IoT.

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

UNIT I **8 Hours**

DEFINING IOT ANALYTICS AND CHALLENGES

Introduction to IoT, applications, IoT architectures, introduction to analytics, IoT analytics challenges.

UNIT II **8 Hours**

IOT DEVICES AND NETWORKING PROTOCOLS

IoT devices, Networking basics, IoT networking connectivity protocols, IoT networking data messaging protocols, Analyzing data to infer protocol and device characteristics;

UNIT III **9 Hours**

IOT ANALYTICS FOR THE CLOUD

Introduction to elastic analytics, Decouple key components, Cloud security and analytics, Designing data processing for analytics, Applying big data technology to storage.

UNIT IV **10 Hours**

EXPLORING IOT

Data: Exploring and visualizing data, Techniques to understand data quality, Basic time series analysis, Statistical analysis.

UNIT V **10 Hours**

DATA SCIENCE FOR IOT ANALYTICS

Introduction to Machine Learning, Feature engineering with IoT data, Validation methods, Understanding the bias–variance trade-off.

FOR FURTHER READING

Use cases for deep learning with IoT data

Total: 45 Hours

Reference(s)

1. Kai Hwang, Min Chen, Big-Data Analytics for Cloud, IoT and Cognitive Computing, Wiley.
2. Hwaiyu Geng, Internet of Things and Data Analytics Handbook, Wiley.
3. John Soldatos, Building Blocks for IoT Analytics Internet-of-Things Analytics, River Publishers Gerardus Blokdyk.
4. 1. Minteer, Andrew, Analytics for the Internet of Things (IoT), Packt Publishing Ltd., 2017.

21EI007 / 21EIH13 ROBOTICS AND AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with the design, functioning and applications of robots.
- To differentiate the robotic sensors, actuators and end-effectors.
- To formulate the control algorithms and path planning algorithms for the robots.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
d. 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.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Identify the evolution of robotics
2. Interpret the basic concepts associated with the design, functioning and applications of robots.
3. Apply the kinematics of a robotic manipulator.
4. Design the control algorithms and path planning algorithms for the robots.
5. Select the suitable sensor, actuator and gripper for the robot.

Articulation Matrix

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

UNIT I **8 Hours**

FUNDAMENTALS OF ROBOTICS

Automation and robots - a brief history of robotics - definition and laws of robotics - anatomy of robot - robot classifications - robot specifications - robot configurations - robot links - robot joints - performance parameter - applications of robots.

UNIT II **11 Hours**

ROBOT KINEMATICS

Robot architecture - pose of a rigid body - coordinate transformation - homogenous coordinates - Denavit and Hartenborg (DH) parameters - forward position analysis - inverse position analysis - velocity analysis: The Jacobian matrix, link velocities, singularity - acceleration analysis. Mobile robots dynamics (Newtonian dynamics).

UNIT III **8 Hours**

ROBOT POWER SOURCES AND END EFFECTOR

Power Sources: Hydraulic, pneumatic and electric drives - mechanical transmission-gear transmission, belt drives, cables, roller chains, rotary to linear motion conversion, rotary to rotary motion conversion. End Effector: Types of end effector - mechanical grippers - vacuum cups - magnetic grippers - adhesive grippers - hooks, scoops, miscellaneous devices - tools as end effector - the robot end effector interface - selection and design of the gripper.

UNIT IV **8 Hours**

ROBOTIC SENSORS AND VISION

Sensors in robotics - classification - tactile, proximity and range sensors - sensors based systems; Introduction to machine vision - the sensing and digitizing function in machine vision - image processing and analysis - training the vision system - robot programming and languages.

UNIT V **10 Hours**

PATH PLANNING, CONTROL OF ROBOTIC MANIPULATORS AND APPLICATIONS

Considerations on trajectory planning - joint interrelated trajectories - cartesian path trajectories - control of robot - PID control - computed torque technique - Multiple robots - Machine interface Robots in manufacturing and non-manufacturing application - Robot cell design - selection of a robot.

FOR FURTHER READING

Rail Guided Vehicles (RGV), Automated Guided Vehicles (AGV) - implementation of robots in industries - various steps - safety considerations for robot operations - Economic Analysis of Robots - Pay back Method, Equivalent Uniform Annual Cost (EUAC) Method, Rate of Return Method.

Total: 45 Hours

Reference(s)

1. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Prentice Hall of India Private Limited, New Delhi, 2010.
2. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, Industrial Robotics, Tata McGraw-Hill Education, 2012.
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2013.
4. K S Fu,Ralph Gonzalez,C S G Lee, Robotics: Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Education, 2010.
5. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering - An integrated approach, Prentice Hall of India, New Delhi, 2012.
6. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, Springer-Verlog Berlin Heidelberg, 2008.

21EI008 / 21EIH14 BUILDING AUTOMATION 3 0 0 3

Course Objectives

- To understand the principles and application of Building Automation system and building process control
- To study the dynamic performance of fire alarm system and various access control systems
- To get knowledge in security systems of different applications

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Develop HVAC system architecture for building automation with human comfort
2. Demonstrate and analyze the process model for heating, cooling and ventilation applications
3. Design and develop different architecture of fire alarm system using field and panel components
4. Identify the appropriate CCTV access control system design for different applications in security system aspects
5. Apply perimeter intrusion technology for advanced security system design applications

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BUILDING AUTOMATION SYSTEM

Fundamentals: Introduction to HVAC - Basic Processes (Heating, Cooling) - Air Properties - Psychometric Chart - Heat Transfer mechanisms - Human Comfort: Human comfort zones - Effect of Heat, Humidity - Heat loss

UNIT II **9 Hours**

PROCESSES

Heating Process & Applications: Boiler, Heater - Cooling Process and Applications: Chillers - Ventilation Process and Applications - Central Fan System - AHU - Exhaust Fans - Unitary Systems - VAV, FCU - Energy Saving concept & methods - Lighting control - Building efficiency improvement - Green Building - Leadership in Energy and Environmental Design (LEED) Certification concept and examples

UNIT III **10 Hours**

FIRE ALARM SYSTEM (FAS)

Introduction to fire alarm system - Fire modes, Principles of operation, FAS Components: Field Components, Panel Components and Applications. Power Supply design for FAS. Cause & effect matrix: Examples. Fire Standards: NFPA 72A, BS 5839, Indian Standards

UNIT IV **9 Hours**

SECURITY SYSTEMS

Introduction to Security Systems, Concepts of Access Control System: Access Components, Access control system Design. CCTV: Camera: Operation & types, Camera Selection Criteria, DVR Based system, DVM, Network design, Storage design and CCTV Applications

UNIT V **8 Hours**

PERIMETER INTRUSION SYSTEM

Concept, Components, Technology and Advanced Applications Security Design: Security system design for verticals

FOR FURTHER READING

Safety Interlocks

Total: 45 Hours

Reference(s)

1. Reinhold A. Carlson, Robert A. Di Giandomenico, Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs), R.S. Means Company, Inc 2012
2. William B. Riddens, Understanding Automotive Electronics, Sixth Edition, Butterworth Heinemann Woburn, 2010.
3. Michael F. Hordeski, HVAC Control in the New Millennium, First edition, Fairmont Press, 2011.
4. NJATC Building Automation Control Devices and applications, First edition, Amer Technical Pub, 2012.

21EI009 / 21EIH15 INTELLIGENT AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concepts associated with Robotic Process Automation.
- To develop practical skills in using RPA tools and platforms to automate repetitive tasks, streamline business processes, and improve operational efficiency.
- To develop skills in implementing intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
d. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Explain the basic concepts of Intelligent Automation, applications and implementation procedures
2. Implement intelligent automation solutions by leveraging AI technologies such as natural language processing, computer vision, and predictive analytics.
3. Design and deploy intelligent automation systems.
4. Outline the advanced topics in intelligent automation, such as cognitive automation, robotic process automation (RPA), and adaptive automation.
5. Apply theoretical knowledge and practical skills to develop innovative solutions that maximize operational efficiency.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO INTELLIGENT AUTOMATION

Introduction to Intelligent Automation(IA) - Differentiating IA from AI - IA technologies - implementation of IA - IA use cases.

UNIT II **9 Hours**

AI TECHNOLOGIES FOR INTELLIGENT AUTOMATION

Introduction to AI technologies used in IA such as natural language processing, computer vision, predictive analytics. AI implementation in robotics.

UNIT III **10 Hours**

INTELLIGENT PROCESS AUTOMATION

Introduction to IPA – Differences between IPA and RPA – Benefits of IPA - Role of Intelligent Process Automation in Automation - Server based robots - Intelligent workflow solutions that aid in management, integration and handoff processes - cognitive agents - optical character recognition - chatbots.

UNIT IV **10 Hours**

COGNITIVE AUTOMATION AND DECISION MAKING

Fundamentals and principles - interdisciplinary nature of cognitive science - representations for information and knowledge - principal technology enablers for cognitive computing - cognitive computing architectures, approaches, applications. Cognitive computing and neural networks - adaptive automation.

UNIT V **8 Hours**

APPLICATIONS

Case studies and real-world examples of successful intelligent automation implementations.

FOR FURTHER READING

Rail Guided Vehicles (RGV), Automated Guided Vehicles (AGV) - implementation of IA in industries - various steps - safety considerations for implementation of IA.

Total: 45 Hours

Reference(s)

1. Bornet, Pascal & Barkin, Ian & Wirtz, Jochen, Intelligent Automation - Learn How to Harness Artificial Intelligence to Boost Business & Make Our World More Human, 2020.
2. Russell, S., Norvig, P. Artificial Intelligence: A Modern Approach. Prentice Hall, 2010.
3. Vijay Raghavan, Venkat Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications, 2016
4. Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018.
5. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant", Independently Published, 1st Edition 2018.

21EI010 / 21EIH16 SMART MANUFACTURING 3 0 0 3

Course Objectives

- To Develop a comprehensive understanding of smart manufacturing concepts, technologies, and their impact on the industry
- To implement and manage smart manufacturing systems, including IoT connectivity, data analytics, and advanced manufacturing technologies.
- To apply theoretical knowledge and practical skills to optimize production processes, enhance quality control, and drive efficiency and productivity in smart manufacturing environments.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
d. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Demonstrate smart manufacturing principles, technologies, and their application in real-world scenarios
2. Implement connectivity solutions and leverage the Internet of Things (IoT) to enable seamless communication and collaboration among machines, systems, and stakeholders.
3. Apply data analytics and artificial intelligence techniques to optimize manufacturing processes, improve product quality, and enable predictive maintenance.
4. Evaluate and select appropriate advanced manufacturing technologies, such as additive manufacturing and robotics, to enhance production efficiency and flexibility.
5. Design and execute strategies for the successful implementation and management of smart manufacturing systems.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Smart manufacturing - implementing smart manufacturing across an industry - Industry 4.0 and international perspective - role of hardware and software in smart manufacturing.

UNIT II **10 Hours**

INDUSTRIAL IOT AND CONNECTIVITY IN SMART MANUFACTURING

Industrial Internet of Things and Cyber Manufacturing Systems(CMS) - Cyber Physical systems(CPS) engineering for manufacturing - Model-Based Engineering of Supervisory Controllers for Cyber-Physical Systems .CPS-Based Manufacturing with Semantic Object Memories and Service Orchestration for Industry4.0 Applications - Integration of a Knowledge Database and Machine Vision within a Robot-Based CPS - Interoperability in Smart Automation of Cyber Physical Systems - Communication and Networking for the Industrial Internet of Things.

UNIT III **10 Hours**

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS FOR MANUFACTURING

Application of CPS in machine tools - Manufacturing CPS (IIOT) - CPS intelligence - Big Data and Machine Learning for the Smart Factory - Solutionsfor Condition Monitoring, Diagnosis and Optimization - Overview of the CPS for Smart Factories Project: Deep Learning,Knowledge Acquisition, Anomaly Detection and Intelligent UserInterfaces.

UNIT IV **8 Hours**

ADVANCED MANUFACTURING TECHNOLOGIES IN SMART MANUFACTURING

Introduction and basic principles - Development of Additive Manufacturing Technology - Generalized Additive Manufacturing Process Chain - Rapid prototyping - Direct Digital Manufacturing - Applications for Additive Manufacture.

UNIT V **9 Hours**

SMART MANUFACTURING TECHNOLOGIES FOR INDUSTRY 4.0

Organizational Transformation towards Industry 4.0 Technologies - The Autonomy of Autonomous Robots - Smart Technologies for Industry 4.0 and Its Future. Digital Twin–Based Smart Manufacturing - Concept and Applications.

FOR FURTHER READING

Applications of Augmented and Virtual Reality in Contemporary Manufacturing Organisations - Cloud-Based Manufacturing Service Selection Using Simulation Approaches

Total: 45 Hours

Reference(s)

1. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing: Concepts and Methods, Elsevier, 2020
2. Sabina Jeschke, Christian Brecher, Tobias Meisen, Denis Özdemir, Tim Eschert, Industrial Internet of Things, Springer, 2017
3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2015
4. Jayakrishna Kandasamy, Kamalakanta Muduli, V. P. Kommula, Purushottam L. Meena, Smart Manufacturing Technologies for Industry 4.0: Integration, Benefits, and Operational Activities, Taylor and Francis, 2023

21EI011 / 21EIH17 AI AND EXPERT SYSTEM FOR AUTOMATION

3 0 0 3

Course Objectives

- To understand the fundamentals of artificial intelligence (AI) and expert systems in the context of automation.
- To implement and train machine learning models for automation tasks.
- To design and develop rule-based expert systems for automation decision-making.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
d. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Interpret the history, applications, and ethical considerations of AI in automation
2. Implement and train machine learning models for automation tasks.
3. Interpret the concepts and techniques of expert systems and knowledge representation in automation.
4. Apply natural language processing (NLP) techniques in automation to enable human-computer interaction and language understanding.
5. Investigate real-world applications of AI and expert systems in various industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO AI AND EXPERT SYSTEMS

Definition and scope of AI - .History and evolution of AI - AI applications in various industries - Ethical considerations in AI - Problem-solving methods in AI - Search algorithms, including depth-first search, breadth-first search, and A* search - Heuristic search and informed search techniques - Constraint satisfaction problems and algorithms

UNIT II **8 Hours**

EXPERT SYSTEMS AND KNOWLEDGE REPRESENTATION

Components and architecture of expert systems- Knowledge representation and reasoning techniques - Rule-based systems and inference engines - Integration of expert systems with other AI techniques

UNIT III **10 Hours**

MACHINE LEARNING ALGORITHMS FOR AUTOMATION

Introduction to machine learning and its relation to expert systems - Supervised, unsupervised, and reinforcement learning algorithms - Training and evaluation of machine learning models - Integration of machine learning with expert systems

UNIT IV **10 Hours**

NATURAL LANGUAGE PROCESSING FOR AUTOMATION

Introduction to natural language processing (NLP) - NLP techniques for language understanding and generation - NLP applications in expert systems, such as chatbots and language-based decision-making - Sentiment analysis and opinion mining in expert systems.

UNIT V **8 Hours**

APPLICATIONS

Process automation - Decision support system - predictive maintenance - supply chain optimization – quality control and inspection – Case study: Develop a comprehensive medical knowledge base containing information information on various diseases, symptoms, risk factors and treatments.

FOR FURTHER READING

Intelligent Data Analysis - Autonomous Systems - cybersecurity.

Total: 45 Hours

Reference(s)

1. Joseph C. Giarratano and Gary D. Riley , Expert Systems: Principles and Programming, 4th edition, 2022
2. Stuart Russell and Peter Norvig , Artificial Intelligence: A Modern Approach, Pearson, 2010
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. Daniel Jurafsky and James H. Martin,Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 2nd edition, Pearson, 2013

21EI012 / 21EIH18 INTELLIGENT CONTROL 3 0 0 3

Course Objectives

- To understand the intelligent control techniques and their applications in various domains
- To design and implement fuzzy logic, neural network, and genetic algorithm-based controllers.
- To apply intelligent control methodologies to address real-world control problems, enhancing system stability, robustness, and responsiveness.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals 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.
d. 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.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Interpret the intelligent control principles and techniques
2. Design and implement intelligent control systems using fuzzy logic.
3. Design and implement intelligent control systems using neural network.
4. Design and implement intelligent control systems using genetic algorithm
5. Outline the challenges in practical implementation of intelligent control system.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO INTELLIGENT CONTROL

Overview of control systems and their significance in various domains - Introduction to intelligent control and its applications - Comparison of conventional control and intelligent control approaches - Ethical considerations and challenges in implementing intelligent control systems.

UNIT II **10 Hours**

NEURAL NETWORK CONTROL

Introduction to artificial neural networks and their architectures - Neural network-based control approaches, such as adaptive control and model predictive control - Training and learning algorithms for neural network controllers - Case studies and applications of neural network control.

UNIT III **9 Hours**

FUZZY LOGIC CONTROL

Introduction to fuzzy logic and fuzzy sets - Fuzzy logic control architecture and inference mechanisms. Design and tuning of fuzzy logic controllers - Applications of fuzzy logic control.

UNIT IV **9 Hours**

GENETIC ALGORITHM CONTROL

Introduction to genetic algorithms and evolutionary optimization - Genetic algorithm-based control strategies, including PID tuning and optimal control - Encoding, selection, crossover, and mutation operations in genetic algorithms - Applications of genetic algorithm control in complex systems.

UNIT V **8 Hours**

INTELLIGENT CONTROL SYSTEM INTEGRATION AND OPTIMIZATION

Integration of different intelligent control techniques for complex systems - Multi-objective optimization in intelligent control system design - Case studies and practical implementation challenges.

FOR FURTHER READING

Adaptive and self-learning control approaches.

Total: 45 Hours

Reference(s)

1. Jagannathan Sarangapani., Neural Network Control of Nonlinear Discrete-Time Systems, CRC press, 2017
2. Derong Liu and Panos J. Antsaklis, Intelligent Control Systems: An Introduction with Examples, 2004
3. Timothy J. Ross , Fuzzy Logic with Engineering Applications, John Wiley 2010
4. Xinjie Yu, Mitsuo Gen, and Runwei Cheng, Introduction to Evolutionary Algorithms, Springer, 2010
5. Pedro Ponce-Cruz and Fernando D. Ramírez-Figueroa, Intelligent Control Systems with LabVIEW, Springer, 2010

21EI013 ANALYTICAL INSTRUMENTS 3 0 0 3

Course Objectives

- To understand the various techniques and methods of analysis that occurs in the various regions of the spectrum
- To impart an adequate knowledge about chromatography method for analysis of industrial gases
- To understand the concepts of interaction of electromagnetic radiation with matter.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits
n. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. Summarize the basic principle of colorimeter and two types of optical instruments
2. Differentiate the chromatographic techniques used for industrial applications
3. Select specific techniques employed for analyzing gas, dissolved component and monitoring different pollutants in air and water
4. Organize three different electrodes and analyzers used for the detection of silicon, sodium and dissolved oxygen using
5. Choose the appropriate radiation techniques (NMR, ESR, and EPR) to determine the elements present in the sample

Articulation Matrix

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

UNIT I **9 Hours**

COLORIMETRY AND SPECTROPHOTOMETRY

Beer-Lambert's law - colorimeters - basic principle of spectroscopy -Emission and absorption of radiation sources and detectors - UV and visible spectrophotometers - single and double beam instruments - IR spectrophotometers - attenuated total reflectance flame photometers - atomic absorption spectrophotometers - FTIR spectrophotometers - flame emission photometers.-mass spectrophotometers

UNIT II **7 Hours**

CHROMATOGRAPHY

Gas chromatography - Detectors - Liquid chromatography - Applications - High pressure liquid chromatography - Applications

UNIT III **10 Hours**

GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS

Gas analyzer: oxygen, NOx and H2S types, IR analyzers, thermal conductivity analyzers - air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides and sulphur dioxide estimation - dust and smoke measurements.

UNIT IV **9 Hours**

PH CONDUCTIVITY AND DISSOLVED COMPONENT ANALYZER

Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors - dissolved oxygen analyzer - sodium analyzer - silicon analyzer.

UNIT V **10 Hours**

NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES

Nuclear radiation - microwave spectroscopy - NMR, ESR and EPR spectroscopy - applications - nuclear radiation detectors - GM counter - proportional counter - solid state detectors - X-ray spectroscopy - detectors - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM)

FOR FURTHER READING

Case Study - Bio-analytical technology, Control systems

Total: 45 Hours

Reference(s)

1. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 2nd edition, 2006.
2. G.W. Ewing, Instrumental Methods of Analysis, McGraw Hill, 2004.
3. Liptak, B.G., Process Measurement and Analysis, CRC Press, 2005.
4. Braun, R.D., Introduction to Instrumental Analysis, McGraw Hill, Singapore, 2006
5. H.W.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, PHI, 2005

21EI014 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To provide an overview of Virtual instruments
- To bring out the overview of the software
- To know about the programming structure of the software
- To familiarize the student with the Applications

Programme Outcomes (POs)

a. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals for solving engineering problems
b. 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
c. 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.
d. 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.
e. 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.
m. Exploit sensors to measure physical quantities and design signal conditioning circuits
n. Apply instrumentation systems and advanced controllers for automation

Course Outcomes (COs)

1. Explain the basics of Virtual or graphical instrumentation concepts
2. Summarize the overview of G programming, labels, data types and debug the G programming
3. Select the appropriate structuring concept to be used in graphical programming
4. Formulate the procedure to install DAQ in various OS and its interfacing methods
5. Implement the IMAQ Motion control and machine vision concepts for industrial application

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

General functional description of digital instrument - Block diagram of a Virtual Instrument - Advantages of Virtual Instruments over conventional instruments - Architecture of a Virtual Instrument and a its relation to the operating system. Advantages of Virtual Instruments over conventional instruments

UNIT II **9 Hours**

SOFTWARE OVERVIEW

VI - Graphical user interfaces - Controls and indicators - 'G' programming - Labels and Text - Shape, size and color - Owned and free labels -Data type, Format, Precision and representation - Data types - Data flow programming -Editing - Debugging and Running a Virtual Instrument – Graphical programming palettes and tools - Front panel objects - Data types

UNIT III **9 Hours**

PROGRAMMING STRUCTURE

FOR Loops, WHILE Loops, CASE Structure, Formula nodes, Sequence structures - Arrays and Clusters - Array Operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O's - Attribute modes Local and Global variables. Bundle/Unbundle by name

UNIT IV **9 Hours**

OPERATING SYSTEM AND HARDWARE ASPECTS

Current trends Operating system requirements - Data Acquisition Card(DAQ) : DAQ hardware, Grounding methods, Resolution, Analog I/O, Digital I/O - DAQ Software Architecture - Configuring the DAQ hardware/software for temperature measurement.

UNIT V **9 Hours**

APPLICATIONS

IMAQ Motion Control: components of a motion control system, configuration, prototyping and development - Interfacing Servomotor and Stepper motor in LabVIEW. Machine Vision: Edge Detection,.

FOR FURTHER READING

PCI bus : Architecture, function, configuring PCI bus in LabVIEW - GPIB : Architecture, function, configuring GPIB in LabVIEW - VISA communication.

Total: 45 Hours

Reference(s)

1. Garry M Johnson, Labview Graphical Programming, Tata McGraw Hill book Co, New Delhi, 2017.
2. Jovitha Jerome, “Virtual Instrumentation Using LabVIEW” PHI Learning Pvt. Ltd 1st Edition, 2010.
3. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming made Easy and Fun, Tata McGraw Hill book Co, New Delhi, 2011.
4. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.

21EI015 INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES

3 0 0 3

Course Objectives

- To understand the process involved in petroleum refineries
- To impact adequate knowledge on the distillation column and its control process
- To understand the controlling concepts of major unit of refineries like distillation column, reactors ,driers, heat exchangers, etc.,
- To be acquainted with the safety measures in petroleum industries

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Explain the scenario of the production and consumption of fossil fuels in India
2. Compare the different types of control distillation process in petroleum industries
3. Analyse the characteristics of physical parameters and control mechanism in chemical reactors
4. Summarize the Process parameters of heat exchange system in petroleum industries
5. Infer the usage of safety instrumentation(zone 0, 1, and 2) to avoid the accidents in industries

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Formation of oil and gas - Petroleum exploration, production and refining - refining capacity in India - consumption of petroleum products in India - constituents of crude oil

UNIT II **10 Hours**

DISTILLATION PROCESS CONTROL

Introduction to P & I diagram - atmospheric distillation of crude oil with P&I diagram - Separation of crude oil - vacuum distillation process - thermal conversion process - Catalytic conversion - control of distillation column -feed control - reflux control - reboiler control

UNIT III **9 Hours**

REACTORS PROCESS CONTROL

Control of chemical reactors: temperature control, pressure control - Dryers: control of dryers - batch dryers - atmospheric and vacuum dryers - continuous dryers

UNIT IV **10 Hours**

HEAT EXCHANGE SYSTEM

Control of heat exchangers and evaporators - variables and degrees of freedom - liquid to liquid heat exchangers - steam heaters - condensers - reboiler and vaporizers - cascade control - feed forward control - Feedback control- Integrated approach - evaporators: types of evaporators

UNIT V **9 Hours**

SAFETY INSTRUMENTATION

Hazardous and non-hazardous area - classification of zone 0, zone 1 & zone 2 - pressurization techniques - zener barrier

FOR FURTHER READING

Stability of distillation column operation, Vacuum dryers, Case Study: Distillation process in Reliance Industries Limited & Bharat Petroleum Corporation ltd. (BPCL).

Total: 45 Hours

Reference(s)

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers Ltd, New Delhi, 2007
2. B.G. Liptak, Instrumentation in Process Industries, Chilton Book Company, New York,1973
3. B.G. Liptak, Instrument Engineers Handbook Volume II, 2003

21EI016 POWER PLANT INSTRUMENTATION AND CONTROL

3 0 0 3

Course Objectives

- To gain knowledge on different methods of power generation
- To provide clear view of the various measurements involved in power generation plants
- To understand about the Piping and Instrumentation (P&I) diagram

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

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.
d. 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.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits
n. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers.

Course Outcomes (COs)

1. To recall different types of power generation methods and to explain the basic building blocks of thermal power plant
2. To summarize the measurement process of electrical and non electrical parameters used in thermal power plant
3. To implement control schemes used for the control of combustion of air, fuel, draught, pulveriser, flue gas dew point and soot blowing
4. To analyze major control schemes for boiler control parameters like feed water, drum level, steam, temperature and boiler interlocks
5. To organize the control methods used in nuclear power plant and safety methods in turbine control

Articulation Matrix

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

UNIT I **9 Hours**

OVERVIEW OF POWER GENERATION

Survey of methods of power generation - hydro, thermal, nuclear, solar and wind power - importance of instrumentation in power generation - thermal power plant - building blocks - combined cycle system - combined heat and power system - sub critical and supercritical boilers-details of boiler processes - P&I diagram of boiler - cogeneration

UNIT II **9 Hours**

MEASUREMENTS IN POWER PLANTS

Electrical measurements - current, voltage, power, frequency, power factor etc.- non electrical parameters -Measurement of feed water flow, air flow, steam flow and coal flow - drum level measurement - steam pressure and temperature measurement - turbine speed and vibration measurement - flue gas analyzer - fuel composition analyzer- pollution monitoring Instruments - dust monitor

UNIT III **9 Hours**

BOILER CONTROL LOOPS I

Coal handling: Pulverizers and Pulverizers control - Furnace Draught control - Combustion control: Fuel/Air ratio, combustion efficiency - oxygen, CO and CO2 trimming, excess air flue gas dew point control - Burners for liquid and solid fuels - burner management - soot blowing operation

UNIT IV **9 Hours**

BOILER CONTROL LOOPS II

Boiler feed water processing and control - Types of boilers like FBC, CFBC, Fluidized Bed - drum level control - steam temperature and pressure control - Super heater control - deaerator control - furnace safety interlocks and boiler interlocks -. boiler efficiency calculation

UNIT V **9 Hours**

NUCLEAR POWER PLANT INSTRUMENTATION AND TURBINE CONTROL

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics - safety instrumentation, reliability aspects. Turbine-control: Types of steam turbines - governing system - Speed and load control - Vibration and shell temperature control - lubricant oil temperature control - cooling system

FOR FURTHER READING

Application: Tidal power plant - Geo-thermal power generation - Solar Power Satellite - Recent trends in thermal power plant.

Total: 45 Hours

Reference(s)

1. Krishnaswamy.K and Ponnibala.M., Power Plant Instrumentation, PHI Learning Pvt.Ltd., New Delhi, 2011
2. Swapan Basu and Ajay Kumar, Power Plant Instrumentation and Control, Elsevier,2015
3. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013
4. Liptak B.G., Instrumentation in Process Industries, Chilton Book Company, 2013
5. Jain R.K., Mechanical and Industrial Measurements,Khanna Publishers, New Delhi, 2013
6. David Lindsley, Power Plant control and Instrumentation, Institution of Electrical Engineers, London, 2000

21EI017 FIBER OPTICS AND LASER BASED 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)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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. Summarize the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Explain 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

Principles of light propagation through a fiber - different types of fibers and their properties - relative merits and demerits - fiber optics production and components - technology of preformed fabrication - fiber drawing - mechanical and thermal characteristics - light sources - photo detectors -source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III **9 Hours**

LASER FUNDAMENTALS

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials - removal and vaporization - calculation of power requirements of laser for material processing

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology

FURTHER STUDY

Fabrications of multi-component glass fibers - loss and bandwidth limiting mechanism - fiber optic imaging.

Total: 45 Hours

Reference(s)

1. J.M. Senior, Optical Fiber Communication - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. G. Keiser, Optical Fiber Communications, McGraw Hill, 2010.
4. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2009
5. Donald J. Sterling, Technicians Guide to Fiber Optics, Delmar publisher, 2009
6. Jelínková, Helena, editor. Lasers for medical applications: diagnostics, therapy and surgery. Elsevier, 2013.

21EI018 INSTRUMENTATION IN FOOD PROCESSING INDUSTRIES

3 0 0 3

Course Objectives

- To provide exposure to various techniques and methods that occurs in the various regions of food analysis
- To get an adequate knowledge about various techniques for analysis of food substances
- To understand the concepts of electrodes and biosensors that has potential applications in food and beverage industries

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Apply instrumentation systems and advanced controllers for automation

Course Outcomes (COs)

1. Exemplify the Role of moisture content in food and also about the measurement of Turbidity and Humidity
2. Classify enzyme sensors, biosensors, Electronics Nose used in food manufacturing industries
3. Summarize the concepts of automatic controllers and Indicators used in food industry
4. Implement chromatography and mass spectrometry to the analysis of food products
5. Execute other Analytical Equipment like Scanning electron microscopy, Tandem Electron Microscopy

Articulation Matrix

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

UNIT I **9 Hours**

MOISTURE, TURBIDITY AND HUMIDITY MEASUREMENTS

Role of moisture content in food - wet and dry method - IR technique. Humidity - Definitions - role in food processing - classical types - wet and dry bulb hygrometer - Electronic methods. Turbidity and colour: Definition and role, standards and units, basic turbidity meter, light scattering and absorbtion type

UNIT II **9 Hours**

FOOD ENZYMES AND FLAVOUR

Food enzymes and flavour : Human olfaction - Importance of enzyme sensors - biosensors -sensing arrays - Electronics Nose.

UNIT III **9 Hours**

CONTROLLERS AND INDICATORS

Basic control concept - Temperature controller in dryer - ration control in food pickling -atmospheric controller in food preservation.

UNIT IV **9 Hours**

CHROMATOGRAPHY AND MASS SPECTROMETRY IN FOOD INDUSTRY

Basics of gas and liquid chromatography - GC and HPLC Application in food analysis - MS application in food analysis

UNIT V **9 Hours**

AUTOMATION IN FOOD INDUSTRY

Sorting - Food chilling and freezing – Fruits and vegetable processing - Packing of food products - Robotics in food industry

FOR FURTHER READING

Food sector robot

Total: 45 Hours

Reference(s)

1. Nielsen, S.S,-Introduction to the chemical analysis of foods- Jones and Bartlett Publishers, Boston, London 2004.
2. Mahindru,S.N, -Food additives. Characteristics, detection and estimation-. Tata Mc Graw-Hill Publishing Company Limited, New Delhi 2000.
3. B.G.Liptak, ed -Instrument Engineers Handbook: Process Measurement and Analysis-, Butterworth &Heinemann, 1995
4. R G. Moreira, T.P Coultate Automatic Control for Food Processing System. 2001.
5. Gouri S Mittal, "Computerized control system in the food industry", Marcel Decker Inc. 1997

21EI019 SEMICONDUCTOR MANUFACTURING 3 0 0 3

Course Objectives

- To characterize the materials based on band gap
- To study the light semiconductor interactions
- To analyze the band gap and defects concentration in fabrication process

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.

Course Outcomes (COs)

1. Infer the band origination in chemical bonding and electrical conductivity
2. Differentiate the materials types based on their band gap values and use this knowledge as per their requirements.
3. Understand the junctions are formed in PN diode and its theory.
4. Contrast the solar cell and it's working with advantages.
5. Examine the band gap, reflection and transmission percentage of a grown film over substrate with contents of defects.

Articulation Matrix

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

UNIT I **9 Hours**

Electronic Materials

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.

UNIT II **9 Hours**

Semiconductors

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.

UNIT III **9 Hours**

Light-Semiconductor Interaction

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

UNIT IV **9 Hours**

Measurements & Engineered Semiconductor Materials

Four-point probe and van der Pauw method for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission.

UNIT V **9 Hours**

Manufacturing and Applications

Semiconductor manufacturing: raw materials, Step-by-step process: Cleaning, Film Deposition, Post-deposition Cleaning, Resist Coating, Exposure, Development, Etching & Implantation of Impurities. Quantum wells, wires, and dots: design, fabrication, and characterization techniques. Hetero-junctions and associated band-diagrams

Total: 45 Hours

Reference(s)

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., (2007).
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).

4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Online course: “Semiconductor Optoelectronics” by M R Shenoy on NPTEL
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL

21EI020 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To understand the fundamentals of the Automotive systems
- To gain knowledge in digital engine control, automotive networking, and diagnostics
- To analyse standards, impacts, and economy of electric vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Describe the basics of automobile dynamics and design electronics.
2. Acquire an overview of automotive components, subsystems, and basics of Electronic Engine Control in today's automotive industry.
3. Use available automotive sensors and actuators while interfacing with microcontrollers/ microprocessors during automotive system design.
4. Understand the networking of various modules in automotive systems, communication protocols, and diagnostics of the sub-systems.
5. Understand standards, impact and economy of Electric Vehicles.

Articulation Matrix

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

UNIT I **9 Hours**

Automotive Fundamentals Overview

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System- Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery --Operating principle.

UNIT II **9 Hours**

Automotive Sensors

Automotive Control System applications of Sensors and Actuators - Variables to be measured, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (02/EGO) Lambda Sensors, Piezoelectric Knock Sensor.

UNIT III **9 Hours**

Digital Engine Control Systems

Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control -Closed loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System- Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics.

UNIT IV **9 Hours**

Automotive Networking and Diagnostics

Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces, Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics.

UNIT V **9 Hours**

Electric Vehicles

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - Legislation and regulation - Standardization - Energy efficiency - Assessing economy of EVs - Fuel economy - Fuel consumption - Greenhouse gas emissions

FOR FURTHER READING

Hybrid Electric Vehicle (HEV)

Total: 45 Hours

Reference(s)

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, John Wiley and Sons, 2012.

21EI021 GREEN ELECTRONICS 3 0 0 3

Course Objectives

- To understand the sustainable practices and principles in electronics manufacturing.
- To implement green electronic solutions, considering energy efficiency, recyclability, and reduction of hazardous materials.
- To evaluate and optimize electronic systems for sustainability, enabling the design and development of eco-friendly electronics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Interpret the principles, regulations, and standards, and their importance in green electronics.
2. Apply sustainable design and manufacturing techniques to develop energy-efficient and environmentally-friendly electronic systems
3. Analyze and evaluate the environmental impact of electronic devices
4. Implement circular economy principles into electronic product design.
5. Attribute the social and economic implications of green electronics.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO GREEN ELECTRONICS

Overview of green electronics and its significance in sustainability - Environmental impacts of electronic devices and e-waste management - Regulatory frameworks and standards for green electronics - Green design principles and life cycle assessment.

UNIT II **9 Hours**

ENERGY EFFICIENCY IN ELECTRONICS

Energy consumption analysis in electronic devices - Techniques for improving energy efficiency, such as power management and low-power design - Energy-efficient components and architectures for electronic systems - Energy harvesting and renewable energy sources for powering electronics.

UNIT III **9 Hours**

MATERIALS AND MANUFACTURING FOR GREEN ELECTRONICS

Sustainable materials selection for electronic components and packaging - Design for disassembly and recycling in electronics manufacturing - Reduction of hazardous substances in electronic products - Green manufacturing techniques, such as clean production and waste reduction.

UNIT IV **9 Hours**

DESIGN FOR CIRCULAR ECONOMY

Circular economy principles and their application to electronics - Remanufacturing and refurbishment strategies for extending product lifecycles - Reverse logistics and closed-loop supply chains for electronic products - End-of-life management and responsible disposal of electronic waste.

UNIT V **9 Hours**

GREEN ELECTRONICS CASE STUDIES

Case studies of successful green electronics initiatives and implementations - Emerging trends and technologies in green electronics, such as eco-design software and sustainable packaging - Social and economic implications of green electronics.

FOR FURTHER READING

Future directions and challenges in advancing green electronics.

Total: 45 Hours

Reference(s)

1. Mohamad K. Hasan Green Electronics: Design and Manufacturing, 2008
2. Ali Emadi and Mehrdad Ehsani , Energy-Efficient Electronics: Principles and Practice, 2016.
3. Casey B. Chiu, Sustainable Electronics: Design for Energy Efficiency and Environmental Responsibility, 2016
4. Martin Charter Design for the Circular Economy: Second Edition, 2017
5. John R. Okyere. Green Electronics: Green Bottom Line Impact on Sustainable Product Design and Profitability , 1999

21EI022 DIGITAL VLSI 3 0 0 3

Course Objectives

- To learn the fundamentals of VLSI design with the IC Manufacturing Process
- To familiarize with VLSI combinational logic circuits design
- To familiarize with VLSI sequential logic circuits design
- To learn the various arithmetic circuits and testing methodologies
- To familiarize with the different FPGA architectures

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.

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

Course Outcomes (COs)

1. Analyze MOS devices and inverter.
2. Design and analyze combinational logic.
3. Design and analyze Sequential logic.
4. Design and analyze data path cells.
5. Design digital logic using FPGA.

Articulation Matrix

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

UNIT I **9 Hours**

MOS TRANSISTOR PRINCIPLES

MOS Technology and VLSI, Pass transistors, NMOS, CMOS Fabrication process and Electrical properties of CMOS circuits and Device modelling. Characteristics of CMOS inverter, Scaling principles and fundamental limits. Propagation Delays, CMOS inverter scaling, Stick diagram, Layout diagrams, Elmore‘s constant, Logical Effort. Case study: Study of technology development in MOS.

UNIT II **9 Hours**

COMBINATIONAL LOGIC CIRCUITS

Static CMOS logic Design, Design techniques to improve the speed, power dissipation of CMOS logic, low power circuit techniques, Ratioed logic .Pass transistor Logic, Transmission CPL, DCVSL, Dynamic CMOS logic, Domino logic, Dual Rail logic, NP CMOS logic and NORA logic.

UNIT III **9 Hours**

SEQUENTIAL LOGIC CIRCUITS

Static and Dynamic Latches and Registers, Timing Issues, Pipelines, Clocking strategies, Memory Architectures, and Memory control circuits.

UNIT IV **9 Hours**

DESIGNING ARITHMETIC BUILDING BLOCKS & TESTING

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Need for testing- Manufacturing test principles- Design for testability. Case study: Analysis of area, power and delay for 16 bit adder and 8 bit multilplier.

UNIT V **9 Hours**

IMPLEMENTATION STRATEGIES

Full Custom and Semicustom Design, Standard Cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures. Demo: Complete ASIC flow using Backend tool and fabrication flow Overall case study: Development of IC in commercial aspects (design, testing and fab cost)

Total: 45 Hours

Reference(s)

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated circuits: A Design Perspective", Prentice Hall of India, 2 nd Edition, 2003.
2. N.Weste, K.Eshraghian, "Principles of CMOS VLSI DESIGN", A system Perspective, 2 nd Edition, Addision Wesley, 2004.
3. A.Pucknell, Kamran Eshraghian, "BASIC VLSI DESIGN", Prentice Hall of India, 3 rd Edition, 2007.
4. M.J. Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997.
5. R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", Prentice Hall of India, 2005.

21EI023 REAL TIME EMBEDDED SYSTEM 3 0 0 3

Course Objectives

- To provide in depth knowledge about embedded processor, its hardware and software
- To understand the embedded system design and their operating system
- To apply knowledge of embedded processor architecture in various applications

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
j. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. To illustrate the architecture and the functionality of ARM Microprocessor
2. To Summaries the architecture and the functionality of computing devices
3. To outline the basic concepts of operating system
4. To Implement a interfacing of networks with Microprocessor/ Microcontroller
5. To design a real time application for various domain using embedded system

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ARM PROCEESORS

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT II **9 Hours**

COMPUTING PLATFORM AND DESIGN ANALYSIS

CPU buses - Memory devices - I/O devices - Memory Protection Units - Memory Management Units - Component interfacing - Design with microprocessors - Development and Debugging - Program design - Model of programs - Assembly and Linking - Basic compilation techniques - Analysis and optimization of execution time, power, energy, program size - Program validation and testing.

UNIT III **9 Hours**

PROCESS AND OPERATING SYSTEMS

Multiple tasks and multi processes - Processes - Context Switching - Scheduling policies - Multiprocessor - Inter Process Communication mechanisms - Evaluating operating system performance - Power optimization strategies for processes - Firmware and Operating Systems for ARM processor.

UNIT IV **9 Hours**

HARDWARE ACCELERATES

Accelerators - Accelerated system design-Distributed Embedded Architecture - Networks for Embedded Systems - Network based design - Internet enabled systems.

UNIT V **9 Hours**

CASE STUDY

Hardware and software co-design - Data Compressor - Software Modem - Personal Digital Assistants - Set-Top-Box, System-on-Silicon - FOSS Tools for embedded system development.

FOR FURTHER READING

Automotive networking, Basics of ABS

Total: 45 Hours

Reference(s)

1. Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide Designing and Optimizing System Software, Morgan Kaufmann publishers, 2004.
2. David E-Simon, An Embedded Software Primer, Pearson Education, 2007.
3. K.V.K.K.Prasad, Embedded Real-Time Systems: Concepts, Design & Programming, Dreamtech Press, 2005.
4. Tim Wilmshurst, An Introduction to the Design of Small Scale Embedded Systems, Pal grave Publisher, 2004.
5. Wayne Wolf, Computers as Components - Principles of Embedded Computer System Design, Morgan Kaufmann Publisher, 2006.

21EI024 SOLAR PV FUNDAMENTAL AND APPLICATIONS 3 0 0 3

Course Objectives:

- To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.
- To understand the construction details and principle of operations of solar photovoltaic system
- To learn the economic and environmental merits of solar energy for variety applications

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation.

Course Outcomes (COs)

1. To learn and study the radiation principles with respective solar energy estimation.
2. To learn about PV technology principles and techniques of various solar cells / materials for lister energy conversion.
3. To learn economic and environmental merits of solar energy for variety applications
4. To understand the constructional details of solar photovoltaic system and its applications
5. To understand the applications of solar energy sources to enhance the passive architecture.

Articulation Matrix

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

UNIT I

SOLAR RADIATION AND COLLECTORS **9 Hours**

Solar angles - day length, angle of incidence on tilted surface - Sunpath diagrams - shadow determination - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - heat capacity effect - testing methods-evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems – compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

UNIT II

APPLICATIONS OF SOLAR THERMAL TECHNOLOGY **9 Hours**

Principle of working, types - design and operation of - solar heating and cooling systems - solar water heaters – thermal storage systems – solar still – solar cooker – domestic, community – solar pond – solar drying.

UNIT III

SOLAR PV FUNDAMENTALS **9 Hours**

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions – metal semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature -efficiency measurements - high efficiency cells - preparation of metallurgical, electronic and solar grade Silicon - production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method - Design of a complete silicon – GaAs- InP solar cell - high efficiency III-V, II-VI multi junction solar cell; a-Si-H based solar cells quantum well solar cell – thermo-photovoltaic.

UNIT IV

SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS **9 Hours**

Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - use of computers in array design - quick sizing method - array protection and troubleshooting - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems.

UNIT V

SOLAR PASSIVE ARCHITECTURE **9 Hours**

Thermal comfort - heat transmission in buildings- bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - radiative cooling - application of wind, water and earth for cooling; shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel. – energy efficient landscape design – thermal comfort - concept of solar temperature and its significance - calculation of instantaneous heat gain through building envelope.

Total: 45 Hours

Reference(s)

1. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
2. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
3. Alan L Fahrenbruch and Richard H Bube, Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press, 1983.
4. Larry D Partain, Solar Cells and their Applications, John Wiley and Sons, Inc, 1995.
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2004.
6. Sodha, M.S, Bansal, N.K., Bansal, P.K., Kumar, A. and Malik, M.A.S. Solar Passive Building, Science and Design, Pergamon Press, 1986.
7. Krieder, J and Rabi, A., Heating and Cooling of Buildings: Design for Efficiency, McGraw-Hill, 1994.

21EI025 PROCESS MODELING AND SIMULATION 3 0 0 3

Course Objectives

- To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.
- To obtain the mathematical model for the real time systems by applying fundamental laws
- To analyze the system performance using simulation of the model with appropriate software

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.

Course Outcomes (COs)

1. To understand the scope and classifications of mathematical modeling
2. To learn about fundamental laws used to obtain mathematical model of the real time systems.
3. To analyze Specific Systems by obtaining suitable mathematical model.
4. To analyze the system performance using simulation of the model with appropriate software
5. To understand the procedure to obtain model based on the laboratory-based approach

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

UNIT I **10 Hours**

INTRODUCTION

Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Classification of models, Model building, Modeling difficulties, Degree-of-freedom analysis, Selection of design variables, Review of numerical techniques, Model simulation

UNIT II **7 Hours**

FUNDAMENTAL LAWS

Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibrium, bubble and dew points.

UNIT III **9 Hours**

MODELING OF SPECIFIC SYSTEMS

Constant and variable holdup CSTRs under isothermal and non-isothermal conditions, Stability analysis, Gas phase pressurized CSTR, Two phase CSTR, Non-isothermal PFR, Batch and semi-batch reactors, Heat conduction in a bar, Laminar flow of Newtonian liquid in a pipe, Gravity flow tank, Single component vaporizer, Multi-component flash drum, Absorption column, Ideal binary distillation column and non-ideal multi-component distillation column, Batch distillation with holdup etc.

UNIT IV **9 Hours**

SIMULATION

Simulation of the models, Sequential modular approach, Equation oriented approach, Partitioning and tearing, Introduction and use of process simulation software (Aspen Plus/ Aspen Hysys) for flow sheet simulation

UNIT V **10 Hours**

MATHEMATICAL MODELS

Writing and solving models for simple chemical processes, use of process simulator for solving models for mixer, pump, compressor, heat exchanger, reactor, absorption/distillation column and steady state flow sheet simulation.

FOR FURTHER READING

Autopilot System, Vibration, Temperature, Pressure Measuring Instruments, Stabilization control instruments

Total: 45 Hours

Reference(s)

1. Nagabhushan. S.Sudha.L.K, "Aircraft instrumentation and Systems", International publishing house Private limited, 2014
2. Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill 1993.
3. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995
4. Treager, S., "Gas Turbine Technology", McGraw Hill 1997

21EI026 SYSTEM IDENTIFICATION 3 0 0 3

Course Objectives

- To provide an overview system identification based on the Non-parametric methods and spectral analysis methods
- To estimate the system parameters using parametric model structures
- To study the system identification using generalized relay feedback identification
- To familiarize the student with the Identification of systems operating in closed loop as well as practical aspects.

Programme Outcomes (POs)

a. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals for solving engineering problems

b. 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

c. 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.

d. 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.

e. 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.

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

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

Course Outcomes (COs)

1. Obtain the mathematical model of a real time system using Non-parametric and spectral analysis methods.
2. Estimate the system parameters using parametric model structures available in the system identification tool box.
3. Determine the mathematical model for stable and unstable system using relay feedback identification methods.
4. Identify the system Parameter in the closed loop system using direct, indirect and Subspace Identification methods.
5. Explain the procedure and limitation in practical aspects of identification for an experimental setup.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

UNIT II **9 Hours**

PARAMETER ESTIMATION METHODS

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method-Exercises using system identification toolbox.

UNIT III **9 Hours**

RELAY FEEDBACK IDENTIFICATION

A generalized relay feedback identification method – model; structure selection- relay feedback identification of stable processes: FOPDT and SOPDT model. Relay feedback Identification of unstable processes: FOPDT and SOPDT model - Illustrative examples

UNIT IV **9 Hours**

CLOSED- LOOP IDENTIFICATION

Identification of systems operating in closed loop: Identifiability considerations – direct identification – indirect identification - Subspace Identification methods: classical and innovation forms, free and structures parameterizations

UNIT V **9 Hours**

PRACTICAL ASPECTS OF IDENTIFICATION

Practical aspects: experimental design – input design for identification, notion for persistent excitation, drifts and de-trending – outliers and missing data – pre-filtering -robustness – Model validation and Model structure determination-case studies. Introduction to Nonlinear System Identification.

FOR FURTHER READING

Bounded but Unknown Disturbances: Identification in the Worst Case - Optimal Algorithms - Optimal Inputs - Robustness Consideration. Algorithms: Computing the Estimates - Recursive Estimation - Kalman Filter Interpretation. Parameter Estimation: Minimizing Prediction Error - Identifiability, Consistency, Biase - Least Squares - Relations between Mimimizing the Prediction Error and the MLE, MAP - Convergence and Consistency - Asymptotic Distribution of Parameter Estimates - The Instrumental-Variable Method.

Total: 45 Hours

Reference(s)

1. Arun K. Tangirala “Principles of System Identification Theory and Practice” CRC Press2018
2. Karel J. Keesman,” System Identification an Introduction”, Springer, 2011.
3. LennartLjung, “System Identification: Theory for the user”, Second edition, Prentice Hall, 1999.
4. Tao Liu, FurongGao, “Industrial Process Identification and control design, Step-test and relay-experiment-based methods”, Springer- Verilog London Ltd, 2012.

21EI027 NON LINEAR CONTROL 3 0 0 3

Course Objectives

- To impart knowledge on phase plane analysis of non-linear systems.
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov’s theory.
- To introduce the concept of sliding mode control.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals for solving engineering problems

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

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

Course Outcomes (COs)

1. Analyse the nonlinear systems using phase plane methods.
2. Investigate the nonlinearities of the system using describing function and limit cycle methods.
3. Determine the stability of the given nonlinear system using Lyapunov methods.
4. Apply the linearization concepts in feedback for stabilize the nonlinear MIMO and SISO systems.
5. Design the sliding mode controller for a given nonlinear MIMO system with simulation.

Articulation Matrix

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

UNIT I **9 Hours**

PHASE PLANE ANALYSIS

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits- Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems - simulation of phase portraits in matlab.

UNIT II **9 Hours**

DESCRIBING FUNCTION

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions-Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles. Simulation of limit cycles in matlab

UNIT III **9 Hours**

LYAPUNOV THEORY

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunov's Direct Method-Positive definite Functions and Lyapunov Functions Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunov's Direct Method-Krasovski's Method-Variable Gradient Method-Physically – Control Design based on Lyapunov's Direct Method.

UNIT IV **9 Hours**

FEEDBACK LINEARIZATION

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-

Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum-Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in matlab

UNIT V **9 Hours**

SLIDING MODE CONTROL

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in MATLAB.

FOR FURTHER READING

Cubature predictive filter - Approximate and Complete Controllability of Nonlinear Systems to A Convex Target Set - Sensitivity Analysis of Self-Excited Oscillations in Nonlinear Control Systems. Application case studies in control of robots, control of cart-pendulum systems, control of active magnetic bearings and UAV control.

Total: 45 Hours

Reference(s)

1. Ramirez, W.; "Computational Methods in Process Simulation", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co., 1990.
3. J A E Slotine and W Li, Applied Nonlinear control, PHI, 1991.
4. Hasan Khalil, "Nonlinear systems and control", Prentice Hall.
5. S H Zak, "Systems and control", Oxford University Press, 2003.
6. Torkel Glad and Lennart Ljung, "Control Theory – Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
7. G. J. Thaler, "Automatic control systems", Jaico publishers, 1993.
8. Felix L. Chernousko, Igor M.Ananievski, Sergey A.Reshmin, "Control of Nonlinear Dynamical Systems Methods and Applications, Springer, First Indian Reprint 2013.

21EI028 ADAPTIVE CONTROL 3 0 0 3

Course Objectives

- To introduce the need for and effects of adaptive control
- To illustrate study the parameter identification of systems.
- To illustrate the self-tuning of PID controllers based on parameter identification.
- To illustrate the model reference adaptive control.
- To introduce practical application through case studies.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals for solving engineering problems

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

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.

d. 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.

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

Course Outcomes (COs)

1. Interpret the effect of parameter variation and principle of adaptive control schemes.
2. Distinguish different parametric identification methods.
3. Compare Deterministic and Stochastic Self Tuning Regulators.
4. Design of model reference adaptive controller
5. Design gain scheduling controller and apply adaptive control schemes for industrial processes.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to adaptive control – Effects of process variations –Adaptive control schemes – Adaptive control problem – Non-parametric identification – Step response method – Impulse response method– Frequency response method.

UNIT II **9 Hours**

PARAMETRIC IDENTIFICATION

Linear in parameter models - ARX – ARMAX – ARIMAX – Least square estimation – Recursive least square estimation – Extended least square estimation – Maximum likelihood estimation – Introduction to non-linear systems identification - Pseudo random binary sequence.

UNIT III **9 Hours**

SELF-TUNING REGULATOR

Deterministic in-direct self-tuning regulators – Deterministic direct self-tuning regulators –Introduction to stochastic self-tuning regulators – Stochastic indirect self-tuning regulator.

UNIT IV **9 Hours**

MODEL REFERENCE ADAPTIVE CONTROLLER

The MIT rule – Lyapunov theory – Design of model reference adaptive controller using MIT rule and Lyapunov theory – Relation between model reference adaptive controller and self-tuning regulator.

UNIT V **9 Hours**

TUNING OF CONTROLLERS AND CASE STUDIES

Design of gain scheduling controller - Auto-tuning of PID regulator – Stability analysis of adaptive controllers – Application of adaptive control in chemical reactor, distillation column and variable area tank system.

FOR FURTHER READING

Initial excitation adaptive control – single and double integrator. Deep Learning – Introduction and applications, Radial Basis function based Neural Network function approximation, Multilayer Neural Networks.

Total: 45 Hours

Reference(s)

1. Karl J. Astrom & Bjorn Wittenmark, 'Adaptive Control', Pearson Education (Singapore), Second Edition, 2003.
2. Shankar Sastry and Marc Bodson, 'Adaptive Control: Stability, Convergence, and Robustness', Prentice-Hall, 1994.
3. I. D. Landau, R. Lozano, and M. M'Saad, 'Adaptive Control', NY: Springer-Verlag, 1998.
4. Gang Tao, 'Adaptive Control Design and Analysis', Wiley-IEEE Press, 2003.
5. Kumpati S. Narendra, Anuradha M. Annaswamy, 'Stable Adaptive Control Systems', Prentice Hall, 1989.
6. Chalam, 'Adaptive Control Systems: Techniques and Applications', CRC Press, 1987.
7. T. C.H.A. Hsia, 'System Identification', Lexington books, 1974.
8. Stephanopoulis G. 'Chemical Process Control', Prentice Hall of India, New Delhi, 1990.

21EI029 DIGITAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- To give basic knowledge in digital control system
- To impart necessary knowledge in stability analysis for discrete system
- To model systems in state space representation
- To provide a solution to state equations and to study various computational algorithms
- To know about the compensators in digital controllers

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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 components and concepts related to the digital control system
2. Determine the response of a discrete time system and Investigate the stability of the discrete time system
3. Design a digital compensator / controller using frequency and time domain technique.
4. Formulate the state space model and compute the solutions of discrete time state space equation.
5. Design the state feedback controller / observer for a discrete time control system.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO DIGITAL CONTROL

Introduction - components and configuration of digital control system - discrete time system representation - sampling theorem - Mathematical modelling of sampling process - zero order hold - first order hold - Data reconstruction.

UNIT II **10 Hours**

MODELING AND STABILITY ANALYSIS DISCRETE-TIME SYSTEMS

Revisiting Z transform - Modified Z transform - Mapping of splane to z plane - Pulse transfer function - Pulse transfer function of closed loop system - Jury stability test - Transient and steady state responses

UNIT III **11 Hours**

DESIGN OF SAMPLED DATA CONTROL SYSTEMS

Root locus method - Bode plot - Lead, lag and lag-lead compensator design using time, frequency domain - Discrete PID Controller - Design of digital control systems with deadbeat response.

UNIT IV **8 Hours**

DISCRETE STATE SPACE MODEL

Introduction to state variable model - Various canonical forms - Characteristic equation, state transition matrix - Solution to discrete state equation - Controllability and observability.

UNIT V **8 Hours**

STATE FEEDBACK DESIGN

Pole placement by state feedback - Set point tracking -controller - Full order observer - Reduced order observer

FOR FURTHER READING

Output feedback design - Linear Quadratic Regulator (LQR) design - Simulation of types of digital controller - Simulation of discrete system to analyse the stability - Simulation of discrete time state equation - Simulation of compensation techniques.

Total: 45 Hours

Reference(s)

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2012.
2. K. Ogata, Discrete time control system, Pearson Education Asia, New Delhi 2011.
3. B.C.Kuo, Digital Control System, 2nd Edition, Oxford University Press, 2010.
4. I.J. Nagarath and M. Gopal, Control System Engineering, New age International Pvt. Ltd, New Delhi 2011.
5. Lawrence J. Kamm, Understanding Electro Mechanical Engineering: An Introduction to Mechatronics, Prentice Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, Mechatronics, Tata McGraw-Hill publishing Company Ltd, 2009.

21EI030 OPTIMIZATION TECHNIQUES FOR CONTROLLER DESIGN

3 0 0 3

Course Objectives

- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals for solving engineering problems
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
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.
d. 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. Translate descriptive statements of the design engineering problems in to a mathematical statement of optimization.
2. Apply the modern methods in optimization for control problems.
3. Design and Tuning a PID controller via optimization technique.
4. Use alternate form of two-phase simplex method called Big-M method
5. Design of optimal low-order feedforward controllers & model based optimization of a controller

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO OPTIMIZATION

Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria – Review of basic calculus concepts – Global optimality.

UNIT II **10 Hours**

MODERN METHODS OF OPTIMIZATION

Genetic Algorithms – Simulated Annealing – Ant colony optimization – Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications.

UNIT III **11 Hours**

PID DESIGN BY OPTIMIZATION & LMI

Introduction, PID Design, Convex-concave Optimization, MIMO PID Tuning via Iterated LMI Restriction, Model and Assumptions, Design Problem, Quadratic Matrix Inequality Form, Linear Matrix Inequality Restriction.

8 Hours

UNIT IV

LINEAR PROGRAMMING

Duality in linear programming – standard primal LP problem, dual LP problem, Treatment of equality constraints, determination of the primal solution from the dual solution, dual variables as Lagrange multipliers, KKT conditions for the LP problem.

8 Hours

UNIT V

DESIGN OF OPTIMAL LOW-ORDER FEEDFORWARD CONTROLLERS & MODEL BASED OPTIMIZATION

Feedforward Structure, Optimal Feedforward Control, Optimal Feedforward Controller Characteristics, Control Signal Considerations, Precompensation, Design Examples. Feedforward controller design using convex optimization and tuning rules for proportional set-point weighting. Plant Models, Controllers and Signals, Error Minimization, Feedforward and Feedback Design, Tuning Rules for Set-Point Weighting.

FOR FURTHER READING

General algorithm for unconstrained minimization methods, rate of convergence, unimodal and multimodal function, reduction of a single variable, one dimensional minimization methods- Equal Interval method, Golden section search method.

Total: 45 Hours

Reference(s)

1. Rao S. S. – 'Engineering Optimization, Theory and Practice' – New Age International Publishers – 2012 – 4th Edition
2. Design of Low-Order Controllers using Optimization Techniques Hast, Martin, 2015
3. Deb K. – 'Optimization for Engineering Design Algorithms and Examples' – PHI –2000
4. Arora J. – 'Introduction to Optimization Design' – Elsevier Academic Press, New Delhi – 2004
5. Saravanan R. – 'Manufacturing Optimization through Intelligent Techniques' – Taylor & Francis (CRC Press) – 2006
6. Hardley G. -'Linear Programming' – Narosa Book Distributors Private Ltd. – 2002

21EI031 / 21EIH07 APPLIED SOFT COMPUTING 3 0 0 3

Course Objectives

- To expose the concepts of feed forward and feed back neural networks.
- To provide adequate about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.

e. 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.

Course Outcomes (COs)

1. Identify the necessity of soft computing techniques
2. Interpret functions and application of Artificial Neural Network
3. Illustrate the concept of fuzziness involved in various systems
4. Explain the working of Genetic Algorithm
5. Design the soft computing techniques for linear and nonlinear systems.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training- applications.

UNIT II **9 Hours**

ARTIFICIAL NEURAL NETWORKS

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memory- and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III **9 Hours**

FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets-basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control-Fuzzification-inferencingand defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

UNIT IV **9 Hours**

GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters- Solution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

UNIT V **9 Hours**

APPLICATIONS

GA application to power system optimization problem- Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural Network interconnection systems- Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox-Stability analysis of fuzzy control systems.

Total: 45 hours

Reference(s)

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education,
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996

21EI032 / 21EIH08 MACHINE LEARNING TECHNIQUES

3 0 0 3

Course Objectives

- To Apply the Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environment that is suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
d. 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.
e. 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 machine learning systems.
2. Implement probabilistic discriminative and generative algorithms for regression and classification problems and analyse the results.
3. Implement an unsupervised algorithm to predict the continuous and categorical data and analyse the results.
4. Implement machine learning algorithms and solve real-world problems.
5. Generate machine learning model for regression and classification problems.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, - hypothesis space and inductive bias, evaluation, cross-validation.

UNIT II **10 Hours**

SUPERVISED LEARNING

Regression-Linear and multilinear regression, polynomial, decision trees, random forest. Classification-k-nearest neighbor algorithm, Classification and Regression Tree, logistic regression, SVM.

UNIT III **10 Hours**

UNSUPERVISED LEARNING

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

UNIT IV **9 Hours**

NEURAL NETWORKS

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

UNIT V **9 Hours**

APPLICATION

Machine Learning Frame works- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

FOR FURTHER READING

Reinforcement Learning, Deep Learning Platform, Generative Adversarial Networks, Adversarial machine learning.

Total: 45 Hours

Reference(s)

1. Stephen Marsland, Machine Learning - An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Second edition, Springer series in Statistics.
4. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, “Foundations of Machine Learning (FOML)”, MIT Press, 2012
5. Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms (UML)”, Cambridge University Press, 2014

21EI033 / 21EIH09 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real-world applications
- To analyze the performance of deep learning architectures for real time applications.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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 mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning.
3. Apply deep learning concepts into text and image processing.
4. Implement deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION TO MACHINE LEARNING

Learning algorithms, Maximum likelihood estimation, Machine Learning Algorithms: Naïve Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

UNIT II **9 Hours**

INTRODUCTION TO DEEP NEURAL NETWORKS

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization.

UNIT III **11 Hours**

DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering.

UNIT IV **11 Hours**

DEEP GENERATIVE MODELS

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

UNIT V **7 Hours**

DEEP REINFORCEMENT LEARNING

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

Total: 45 Hours

Reference(s)

1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
3. mberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
4. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
5. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

21EI034 / 21EIH10 PYTHON PROGRAMMINGFOR AI AND ML

3 0 0 3

Course Objectives

- To study uninformed and Heuristic search techniques.
- To introduce Machine Learning and supervised learning algorithms
- To study ensembling and unsupervised learning algorithms.

Programme Outcomes (POs)

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

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

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.

d. 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.
e. 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. Use appropriate search algorithms for problem-solving
2. Apply reasoning under uncertainty for the models
3. Design of supervised learning models for the application
4. Design of ensembling and unsupervised models for the application
5. Design of deep learning neural network models for the application

Articulation Matrix

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

UNIT I **9 Hours**

PROBLEM SOLVING

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)

UNIT II **9 Hours**

PROBABILISTIC REASONING

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT III **9 Hours**

SUPERVISED LEARNING

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests

UNIT IV **9 Hours**

ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT V **9 Hours**

NEURAL NETWORKS

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

Total: 45 Hours

Reference(s)

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education,2007
2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
6. Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition,1997.
7. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.

21EI035 / 21EIH11 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To familiarize with the basic concepts and models of the operations research
- To use transportation and assignment model techniques for effective decisions–making.
- To optimization that are tailored to large-scale statistics and machine learning problems

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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. Formulate the basics of convex optimization in linear programming.
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Understand the fundamental concepts of Genetic Algorithm.

4. Analyse the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Acquire the knowledge about various optimization techniques involved in PSO.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF CONVEX OPTIMIZATION

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

UNIT II **9 Hours**

STOCHASTIC AND NONCONVEX OPTIMIZATION

Dual averaging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

UNIT III **9 Hours**

MODERN OPTIMIZATION IN GA

Genetic algorithm- Introduction - biological background - traditional optimization and search techniques - Genetic basic concepts - operators – Encoding scheme – Fitness evaluation – crossover - mutation - genetic programming – multilevel optimization – real life problem- advances in GA

UNIT IV **9 Hours**

GENETIC PROGRAMMING

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems

UNIT V **9 Hours**

PARTICLE SWARM OPTIMIZATION

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO) - Formulations, Pseudo-code. Applications of PSO and ACO.

Total: 45 Hours

Reference(s)

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International,
2. Stephen Boyd and Lieven Vandenberghe's book: Convex Optimization.
3. Nesterov's old book: Introductory Lectures on Convex Optimization: A Basic Course
4. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
5. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers.

21EI036 / 21EIH12 NATURAL LANGUAGE PROCESSING **3 0 0 3**

Course Objectives

- Understand the representation and processing of Morphology and Part-of Speech Taggers
- Express different aspects of natural language syntax and the various methods used for processing syntax
- To know about various applications of natural language processing

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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 cultural, societal, and environmental considerations.
f. Apply reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the context of technological change.
m. Measure physical parameters for real time industrial applications by identifying appropriate sensors and designing suitable conditioning circuits
n. Develop and implement advanced control schemes for the next level of automation in multiple platforms using industrial controllers

Course Outcomes (COs)

1. Identify the different linguistic components of given sentences.
2. Design a morphological analyzer for a language using finite state automata concepts
3. Implement a parser by providing suitable grammar and words
4. Recognize the semantic role of the sentence and implement the semantic parsing
5. Apply the machine translation and statistical translation to extract the information from the sentence

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Natural Language Processing tasks in syntax, semantics, and pragmatics -Issues - Applications - The role of machine learning - Probability Basics -Information theory - Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models

UNIT II **9 Hours**

MORPHOLOGY AND PART OF SPEECH TAGGING

Linguistic essentials - Lexical syntax- Morphology and Finite State Transducers - Part of speech Tagging - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models – Transformation-based Models - Maximum Entropy Models. Conditional Random Fields

UNIT III **10 Hours**

SYNTAX PARSING

Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context-Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs

UNIT IV **10 Hours**

SEMANTIC ANALYSIS

Representing Meaning - Semantic Analysis - Lexical semantics - Word-sense disambiguation - Supervised –Dictionary-based and Unsupervised Approaches - Compositional semantics- Semantic Role Labelling and Semantic Parsing - Discourse Analysis.

UNIT V **8 Hours**

APPLICATIONS

Named entity recognition and relation extraction- Information Extraction (IE) using sequence labelling Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation - Question Answering- VXML Applications

FOR FURTHER READING

Word sense disambiguation-discourse analysis and lexical resources

Total: 45 Hours

Reference(s)

1. Daniel Jurafsky and James H. Martin "Speech and Language Processing", Second Edition, Prentice Hall, 2014
2. Christopher D. Manning and Hinrich Schuetze, "Foundations of Statistical Natural Language Processing", MIT Press, 2014.
3. Roland R. Hausser, "Foundations of Computational Linguistics Human- Computer Communication in Natural Language", Springer, 2014.

21EI037 / 21EIH01 BIO MEDICAL INSTRUMENTATION **3 0 0 3**

Course Objectives

- To understand the role of instrumentation in bio medical engineering field
- To get ample knowledge on Electro-physiological and non-electric parameter measurement
- To understand principles of medical imaging - CT, MRI, diagnostic and therapeutic devices

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
f. 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.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications
n. Design, develop and realize advanced control schemes in different platforms such as microcontroller, PLC, SCADA, DCS and other modern controllers for next level of automation

Course Outcomes (COs)

1. Analyze the human physiology and functioning systems of various organs
2. Classify the various electrodes and signal conditioning for electro physiological measurements
3. Examine the techniques for non-electrical parameter measurements like heart rate, respiration rate and blood pressure measurements
4. Construct the techniques used in medical image analysis and biotelemetry
5. Select the appropriate assistive and therapeutic devices for illness

Articulation Matrix

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

UNIT I **9 Hours**

HUMAN PHYSIOLOGY AND BIO POTENTIAL ELECTRODES

Cell and their structures - action and resting potential - nervous system: functional organization of the nervous system, structure of nervous system, neurons, synapse -transmitters and neural communication - cardiovascular system- Physiology of heart and lungs - Circulation and respiration.

UNIT II **9 Hours**

ELECTRO-PHYSIOLOGICAL MEASUREMENT

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Electrodes - Micro, needle and surface electrodes - electrical safety - grounding and isolation - Transducer - Selection criteria Einthoven triangle - ECG - EEG - EMG - Lead systems and recording methods - Typical waveforms

UNIT III **9 Hours**

NON - ELECTRICAL PARAMETER MEASUREMENTS

Measurement of blood pressure - Sphygmomanometer - Phonocardiogram - Body Plethysmography - pH of blood - Pulse oximeter - Spirometry

UNIT IV **9 Hours**

MEDICAL IMAGING PARAMETER MEASUREMENTS

X- RAY machine - Computer Tomography - Magnetic Resonance Imaging system - Ultrasonography - Endoscopy - Bio-Telemetry

UNIT V **9 Hours**

DIAGNOSTIC AND THERAPEUTIC DEVICES

Cardiac Pacemakers - Defibrillators - Ventilators- Heart Lung machine - Dialyser- Diathermy - Neurostimulator - Elements of audio and visual aids

FOR FURTHER READING

Case Study - Non-invasive Glucose Estimation, Medical Disasters

Total: 45 Hours

Reference(s)

1. R.S.Khandpur, Hand Book of Bio-Medical instrumentation, Tata McGraw Hill publishing company Ltd., 2016
2. J.G. Webster, Medical Instrumentation: Application and Design, John Wiley and Sons, New York, 2010
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Tata McGraw Hill, 2007
4. E. W. Golding and F. C. Widdis, Electrical measurements and measuring instruments, Ed.5, Pitman Publishing Ltd., London, 1963
5. Joseph, A., A. Joseph, and Administer. Theory and Problems of Electric Circuits. Mc Graw Hill., 1994.
6. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication

21EI038 / 21EIH02 DIGITAL IMAGE PROCESSING 3 0 0 3

Course Objectives

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Understand the basics and fundamentals of digital image processing and 2D-transforms.
2. Outline the techniques of smoothing, sharpening and enhancement in digital images.
3. Analyse the segmentation and features extraction techniques.
4. Execute the restoration concepts and filtering techniques.
5. Implement the image compression using lossy and lossless compression techniques.

Articulation Matrix

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

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Fundamentals of Image processing: Elements of digital image processing systems, Elements of visual perception, Image sensing and acquisition, Image sampling and quantization. Basic relationships between pixels- Two-dimensional mathematical preliminaries

UNIT II **9 Hours**

IMAGE ANALYSIS

Image Transforms: DFT, DCT, Hadamard, Haar, KLT, SVD, Wavelet Transform and Slant transform Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Homomorphic filtering, Frequency domain: Image smoothing and sharpening using frequency domain filters.

UNIT III **9 Hours**

IMAGE SEGMENTATION

Edge detection: Point, line and edge Detection, Detection of isolated points, Line detection, Edge models, Basic edge detection, Edge linking and boundary detection. Thresholding - basic global thresholding, Otsu's method, Multiple, Variable and multivariable thresholding, Region splitting and Region Merging

UNIT IV **9 Hours**

IMAGE RESTORATION AND RECOGNITION

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Constrained Least square filtering, inverse filtering, Wiener Filtering, Wiener filtering, Geometric transformations, Image Recognition: Patterns and pattern classes, Matching-Minimum Distance classifiers.

UNIT V **9 Hours**

IMAGE COMPRESSION AND COLOUR IMAGE PROCESSING

Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-length coding, Lossless and Lossy predictive coding, Block transform coding, Wavelet coding, Image Compression Standards. Color image processing fundamentals: Pseudo color image processing- Basics of full color image processing.

Total: 45 Hours

Reference(s)

1. Digital Image Processing, C. Rafeal Gonzalez and E. Richard Woods, Pearson Education, Fourth Edition, 2018
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2015.
3. Digital Image Processing, S Jayaraman, S Esakkirajan T Veerakumar, Mc Graw-Hill, 2010.
4. Digital Image Processing, K. William Pratt, John Wiley, 2007.
5. Digital Image Processing Using MATLAB, C. Rafeal Gonzalez, McGraw Hill, 2017
6. Image Processing Theory, Algorithm and Architectures, M.A. Sid Ahmed, McGraw-Hill, 1995.

21EI039 / 21EIH03 BIO SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To study the characteristics of different bio signals
- To learn linear and non-linear filtering techniques to extract desired information
- To understand various techniques for automated classification and decision making to aid diagnosis

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Preprocess the Biosignals.
2. Analyze biosignals in time domain & to estimate the spectrum.
3. Apply wavelet detection techniques for biosignal processing.
4. Classify Biosignals using neural networks and statistical classifiers.
5. Extract the features using multivariate component analysis.

Articulation Matrix

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

UNIT I **9 Hours**

BIOSIGNAL AND SPECTRAL CHARACTERISTICS

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II **9 Hours**

TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

Time series analysis – linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation –Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III **9 Hours**

ADAPTIVE FILTERING AND WAVELET DETECTION

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV **9 Hours**

BIOSIGNAL CLASSIFICATION AND RECOGNITION

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

UNIT V **9 Hours**

TIME FREQUENCY AND MULTIVARIATE ANALYSIS

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA,ICA.

Total: 45 Hours

Reference(s)

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach'',Pearson education Ltd., 2004.
5. Raghuveer M. Rao and Ajith S.Bopardikar, "Wavelets transform – Introduction to theory and its applications", Pearson Education, India, 2000.
6. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3 rd Edition, 2010.

21EI040 / 21EIH04 HUMAN ASSISTIVE DEVICES 3 0 0 3

Course Objectives

- To study the role and importance of medical assist devices
- To get exposed to functioning of rehabilitation and related aspects.
- To learn concepts of the design aspects of prosthetic and orthotic devices.
- To become familiar with hearing and visual aids.

Programme Outcomes (POs)

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

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

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.
d. 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.
e. 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.
f. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Understand the various electro mechanical techniques that will help failing heart
2. Analyse the functioning of the hemodialysers for the clearance of urea from the blood.
3. Understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
4. Analyse the various orthodic devices and prosthetic devices to overcome orthopaedic problems.
5. Implement the rehabilitation and electrical stimulation techniques used in clinical applications.

Articulation Matrix

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

UNIT I **9 Hours**

BASIC COMPONENTS OF BIOMEDICAL SYSTEMS AND CARDIAC ASSIST DEVICES

Basic components of a biomedical system - Amplifiers - Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - Bio amplifier circuits - Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

UNIT II **9 Hours**

HEMODIALYSERS

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III **9 Hours**

HEARING AND VISUAL AIDS

Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids. Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually Challenged, Text to voice converter, Screen readers

UNIT IV **9 Hours**

PROSTHETIC AND ORTHODIC DEVICES

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, sensory assist devices.

UNIT V **9 Hours**

REHABILITATION MEDICINE AND STIMULATORS

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device, Transcutaneous electrical nerve stimulator, bio-feedback.

Total: 45 Hours

Reference(s)

1. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006
2. Levine S.N. (ed), "Advances in Bio-medical engineering and Medical physics", Vol. I, II, IV, inter university publications, New York, 1968
3. Short Textbook of Prosthetics and Orthotics - R Chinnathurai- Jaypee BrothersMedical Publishers (P) Ltd-2010
4. R.S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2 nd Edition, Edition- 2003
5. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976.
6. Albert M.Cook and Webster J.G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1982.

21EI041 / 21EIH05 MEDICAL IMAGING SYSTEMS 3 0 0 3

Course Objectives

- To study the medical image acquisition and reconstruction techniques
- To get exposed to functioning of radio isotopic imaging equipments.
- To learn concepts of the MRI, image acquisition and reconstruction techniques.
- To become familiar with X-ray and ultra sound imaging systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
e. 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.
f. 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.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Understand the nuclear medical imaging techniques for acquisition of images.
2. Analyse the x-ray medical imaging techniques and its imaging quality.
3. Apply the concept of Neuro Magnetic Science in MRI.
4. Analyse the principle and operation modes of Ultrasound Imaging.

5. Implement the radio isotopes and thermography for imaging techniques.

Articulation Matrix

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

UNIT I **9 Hours**

MEDICAL IMAGE FUNDAMENTALS AND ACQUISITION

Introduction to Imaging Techniques - Single crystal scintillation camera - Principles of scintillation camera - multiple crystal scintillation camera - solid state camera - rectilinear scanner. Image Reconstruction - Mathematical Preliminaries for Two and Three dimensional Image Reconstructions - Radon Transform- Projection Theorem - central slice Theorem- Sinogram.

UNIT II **9 Hours**

X- RAY AND COMPUTED TOMOGRAPHY

Priniciples of sectional imaging – scanner configuration – data acquisition system – image formation principles – conversion of x-ray data in to scan image – 2-D image reconstruction techniques –Iteration and Fourier method – types of CT scanners.

UNIT III **9 Hours**

MAGNETIC RESONANCE IMAGING

Priniciples of MRI pulse sequence – image acquisition and reconstruction techniques –MRI instrumentation magnetic gradient system RF coils – receiver system functional MRI– Application of MRI

UNIT IV **9 Hours**

ULTRASOUND IN MEDICINE

Production of ultrasound – properties and principles of image formation, capture anddisplay – principles of A-mode, B-mode and M-mode display – Doppler ultra sound andcolour flow mapping – applications of diagnostic ultra sound.

UNIT V **9 Hours**

RADIO ISOTOPIC AND THERMAL IMAGING

Rectilinear scanners – linear scanners – SPECT – PET Gamma camera radio nuclides for imaging – emission computed CT. Physics of thermography – imaging systems – pyroelectric vidicon camera clinicalthermography – liquid crystal thermography

Total: 45 Hours

Reference(s)

1. Steve Webb, “The physics of medical imaging”, Adam Hilger, Bristol, England, Philadelphia, USA, 1988.
2. Jerry L.Prince and Jnathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2006
3. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics: A John Wiley & sons, Inc., Publication, Fourth Edition 2002.
4. Z.H. Cho., J-oie, P. Jones and Manbir Singh,Foundations of Medical Imaging: John Wiley and sons Inc. 2003
5. P.Raghunathan, “Magnetic Resonance Imaging and Spectroscopy in Medicine”Concepts and Techniques, Orient Longman, 2007

21EI042 / 21EIH06 BRAIN COMPUTER INTERFACE 3 0 0 3

Course Objectives

- To study the basic concepts of brain computer interface
- To get exposed to various signal acquisition methods.
- To learn concepts of the signal processing methods used in brain computer interface.
- To become familiar with various machine learning methods of BCI.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
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.
d. 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.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevanttotheprofessionalengineering practice.
m. Identify suitable sensors and design signal conditioning circuits to measure physical parameters for industrial applications

Course Outcomes (COs)

1. Understand the various brain computer interface types and monitoring hardwares.
2. Analyse the functioning of the activation patterns and brain stimulations.
3. Execute the various feature extraction methods.
4. Analyse the machine learning methods for brain computer interface.
5. Implement the brain computer interface models in various applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BRAIN COMPUTER INTERFACE

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT II **9 Hours**

BRAIN ACTIVATION

Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III **9 Hours**

FEATURE EXTRACTION METHODS

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence

UNIT IV **9 Hours**

MACHINE LEARNING METHODS FOR BRAIN COMPUTER INTERFACE

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT V **9 Hours**

APPLICATIONS OF BRAIN COMPUTER INTERFACE

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs:P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

Total: 45 Hours

Reference(s)

1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.
3. Ella Hassianien, A A Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.
4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
5. Ali Bashashati, MehrdadFatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" Journal of Neural Engineering, 2007.

21OCE01 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

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

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.

21OCS01 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.

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 **10 Hours**

POLYMORPHISM AND FILE STREAMS

Polymorphism and File Streams Virtual Function - Friend Function - Static Function- Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **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.

21OCS02 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.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

21OCS03 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.

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.

8 Hours

UNIT II

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.

21OCS04 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

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**

TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**

MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**

TEACHING-LEARNING PROCESS

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**

APPLICATIONS

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

21OCS05 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

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 **9 Hours**

METHODS

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive

Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**

WEB ANALYTICS

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.

21OEC01 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.

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.

21OEC02 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.

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.

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.

21OEC03 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

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.

21OEC04 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.

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

21OME01 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.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application

5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

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

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating
ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015.
6. http://www.springer.com/978-1-4939-2112-6
7. www.grabcad.com, www.all3dp.com

21OME02 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

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

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

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications., 2010.
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2006.
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.

21OME03 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.

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.

3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

21OME04 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.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

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

UNIT I **8 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 space

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

21OBT01 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.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		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 andthermal 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, purificationof 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.

21OFD01 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.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

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

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

21OFD02 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

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.

21OFD03 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

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.

21OFD04 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

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

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

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

21OFT01 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.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

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

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

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

21OFT02 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

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

21OFT03 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

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations, 2014.
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013.
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013.
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

21OPH01 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

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

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

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes-structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald 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.

21OPH02 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

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

21OPH03 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

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

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 (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homo junction 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.

21OPH04 BIO-PHOTONICS 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.

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOPHOTONICS

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**

PHOTOBIOLOGY

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photoexcitation – photo-
induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**

BIO-NANO-PHOTONICS

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**

TISSUE ENGINEERING WITH LIGHT

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters of tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**

BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Introduction to Biophotonics, ParasN.Prasad, WileyInter-science, AJohnWiley & Sons, Inc., Publication (Class notes are developed mainly based on this book.)

2. Introduction to Biomedical Imaging, Andrew G.Webb, 2002, IEEE Press.
3. Biomedical Optics: Principles and Imaging, Lihong.V.Wang, Hsin.-I.Wu, 2007, Wiley Interscience 2007. & "An Introduction to Biomedical Optics", R.Splinterand B.A.Hooper, Taylor & Francis
4. Bioimaging Current Concepts in Light and Electron Microscopy, DouglasE.Chandler & Robert W.Roberson, Jones and Bartlett publishers.
5. Optical Imaging and Microscopy : Techniques and Advanced Systems, Peter Török and Fu-JenKao, 2004, Springer.

21OPH05 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 supramolecules
- To summarize the soft matter proprties of structures and components of life

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

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

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric

hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

9 Hours

UNIT III

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

9 Hours

UNIT IV

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

9 Hours

UNIT V

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

Reference(s)

1. Richard A L Jones, Soft Condensd 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 M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

21OCH01 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

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", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 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, 2008.
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.

6. http://corrosion-doctors.org/Corrosion-History/Eight.html

21OCH02 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

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. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2008.
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008.
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004.
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011.
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

21OCH03 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.

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

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

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium,and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018.
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.

5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

21OMA01 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.

Course Outcomes (COs)

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

21OGE01 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.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority – Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource – Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour – Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication - Barrier in communication Effective communication - Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.

5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

21OGE02 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

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act - Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments - promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance - functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
3. Akhileshwar Pathak, Legal Aspects of Business

21OGE03 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

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

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

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases).

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi, 2003.
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill, 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.
6. http://niesbud.nic.in/agencies.html

21OGE04 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

Course Outcomes (COs)

1. Understand religo-cultural diversity of the country and its impact on the lives of the people and their beliefs

2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

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

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation.
Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness. Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.
Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.
COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/