B.E. (Electrical and Electronics Engineering)

2022 Regulations, Curriculum & Syllabus

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

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CONTENTS

VISION OF THE DEPARTMENT

- To produce competent Electrical and Electronics Engineers to fulfill the industry and society needs.

MISSION OF THE DEPARTMENT

- To provide a unique environment with facilities to inculcate self-learning and to meet the challenges in the field of electrical, electronics, and allied engineering.
- To enhance the knowledge and skills of students, members of faculty and supporting staff through professional training.
- To strengthen academia and industry collaboration for improving the problem solving, interpersonal and entrepreneur skills.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

On successful completion of four year BE degree programme quite a few years after graduation our graduates will:

- PEO1: Apply, analyze, design and create products and provide solutions in the field of Electrical and Electronics Engineering.
- PEO2: Involve in multidisciplinary teams and apply the knowledge and skills of Electrical and Electronics Engineering to create sustainable solutions for global, environmental and communal needs in an ethical way.
- PEO3: Engage in lifelong learning to work in core domain / software / pursue higher studies /research / entrepreneur.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

a. **PO1: Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.

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

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

d. **PO4: Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.

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

f. **PO6: The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to theprofessional engineering practice.

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

h. **PO8: Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and normsof the engineering practice.

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

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

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

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

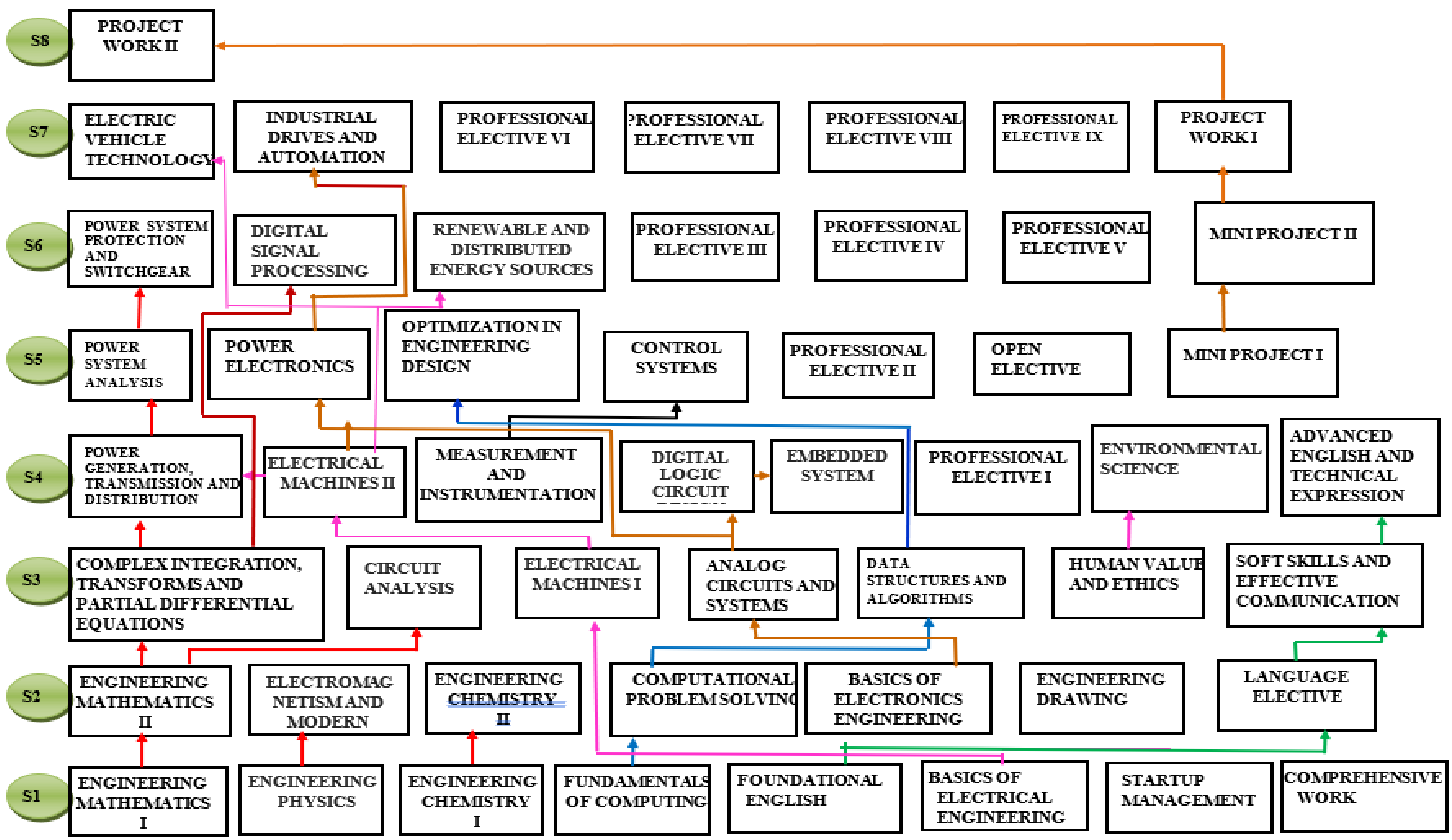
I. **PSO1:** Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

II. **PSO2:** Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcome(s)												Programme Specific Outcome(s)	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	I	II
I	X	X	X	X	X		X	X	X	X		X	X	X
II	X		X	X	X	X		X	X	X	X			X
III	X	X		X		X	X				X	X	X	

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Minimum Credits to be Earned : 163

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	3	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	50	50	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	50	50	100	EEC
22HS003	தமிழர் மரபு HERITAGE OF TAMILS#*	1	0	0	1	1	40	60	100	HSS
22EE108	COMPREHENSIVE WORK$	0	0	2	1$	2	100	0	100	EEC
Total		**15**	**1**	**10**	**21**	**26**	-	-	-	-

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNETISM AND MODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	50	50	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	50	50	100	HSS
22HS006	தமிழரும் தொழில்நுட்பமும் TAMILS AND TECHNOLOGY^*	1	0	0	1	1	40	60	100	HSS
22HS009	COCURRICULAR OR EXTRACURRICULAR ACTIVITY*	-	-	-	NC	-	100	-	100	HSS
Total		**15**	**1**	**10**	**21**	**28**	-	-	-	-

* Applicable for the students admitted during academic year 2024-2025. The lateral entry students have to complete these courses during III and IV semesters.

Students admitted during academic year 2022-2023 studied this course in semester II.

^ Students admitted during academic year 2022-2023 studied this course in semester III.

$ Applicable only for the students admitted during academic year 2022-2023.

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EE301	COMPLEX INTEGRATION, TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	3	1	0	4	4	40	60	100	BS
22EE302	CIRCUIT ANALYSIS	3	1	0	4	4	40	60	100	ES
22EE303	ELECTRICAL MACHINES I	3	1	0	4	4	40	60	100	PC
22EE304	ANALOG CIRCUITS AND SYSTEMS	3	0	2	4	5	50	50	100	PC
22EE305	DATA STRUCTURES AND ALGORITHMS	2	0	2	3	4	50	50	100	PC
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	40	100	EEC
Total		**16**	**3**	**6**	**22**	**25**	**-**	**-**	**-**	**-**

IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22EE401	POWER GENERATION, TRANSMISSION AND DISTRIBUTION	3	1	0	4	4	40	60	100	PC
22EE402	ELECTRICAL MACHINES II	3	0	2	4	5	50	50	100	PC
22EE403	MEASUREMENT AND INSTRUMENTATION	3	0	2	4	5	50	50	100	PC
22EE404	DIGITAL LOGIC CIRCUIT DESIGN	3	0	2	4	5	50	50	100	PC
22EE405	EMBEDDED SYSTEMS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	NC	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	60	40	100	HSS
22HS010	SOCIALLY RELEVANT PROJECT*	0	0	2	NC	-	100	0	100	HSS
Total		**20**	**1**	**12**	**24**	**33**	**-**	**-**	**-**	**-**

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

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EE501	POWER SYSTEM ANALYSIS	3	0	2	4	5	50	50	100	PC
22EE502	POWER ELECTRONICS	3	0	2	4	5	50	50	100	PC
22EE503	OPTIMIZATION IN ENGINEERING DESIGN	3	1	0	4	4	40	60	100	PC
22EE504	CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE
22EE507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
Total		**18**	**2**	**6**	**23**	**26**	**-**	**-**	**-**	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EE601	POWER SYSTEM PROTECTION AND SWITCHGEAR	3	0	0	3	3	40	60	100	PC
22EE602	DIGITAL SIGNAL PROCESSING	3	1	0	4	4	40	60	100	PC
22EE603	RENEWABLE AND DISTRIBUTED ENERGY SOURCES*	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
22EE607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**18**	**1**	**4**	**21**	**23**	**-**	**-**	**-**	**-**

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

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EE701	ELECTRIC VEHICLE TECHNOLOGY	3	0	0	3	3	40	60	100	PC
22EE702	INDUSTRIAL DRIVES AND AUTOMATION	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
22EE707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**18**	**0**	**6**	**21**	**24**	**-**	**-**	**-**	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EE801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total		**0**	**0**	**20**	**10**	**20**	**-**	**-**	**-**	**-**

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

PROFESSIONAL ELECTIVES									
VERTICAL I - POWER SYSTEMS									
22EE001	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
22EE002	POWER QUALITY	3	0	0	3	3	40	60	100	PE
22EE003	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
22EE004	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22EE005	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
22EE006	POWER SYSTEM DEREGULATION	3	0	0	3	3	40	60	100	PE
22EE045	FLEXIBLE AC TRANSMISSION SYSTEMS	3	0	0	3	3	40	60	100	PE
VERTICAL II - POWER ELECTRONICS AND DRIVES									
22EE007	ADVANCED POWER SEMICONDUCTOR DEVICES	3	0	0	3	3	40	60	100	PE
22EE008	ADVANCED POWER CONVERTERS	3	0	0	3	3	40	60	100	PE
22EE009	MODERN RECTIFIERS AND RESONANT CONVERTERS	3	0	0	3	3	40	60	100	PE
22EE010	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3	3	40	60	100	PE
22EE011	ELECTRIC DRIVES AND CONTROL	3	0	0	3	3	40	60	100	PE
22EE012	POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SOURCES	3	0	0	3	3	40	60	100	PE
VERTICAL III - ELECTRIC VEHICLE TECHNOLOGY									
22EE013	ELECTRIC VEHICLE ARCHITECTURE	3	0	0	3	3	40	60	100	PE
22EE014	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EE015	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	3	0	0	3	3	40	60	100	PE
22EE016	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	3	0	0	3	3	40	60	100	PE
22EE017	GRID INTEGRATION OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EE018	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EE041	IoT FOR INDUSTRY AUTOMATION	3	0	0	3	3	40	60	100	PE

22EE042	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE
VERTICAL IV - GREEN ENERGY TECHNOLOGY										
22EE019	SOLAR ENERGY CONVERSION SYSTEMS	3	0	0	3	3	40	60	100	PE
22EE020	WIND POWER TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22EE021	FUEL CELL SYSTEMS	3	0	0	3	3	40	60	100	PE
22EE022	RENEWABLE ENERGY SYSTEMS INSTALLATIONS AND MAINTENANCE	3	0	0	3	3	40	60	100	PE
22EE023	ENERGY STORAGE SYSTEMS	3	0	0	3	3	40	60	100	PE
22EE024	GRID INTEGRATION OF RENEWABLE SOURCES	3	0	0	3	3	40	60	100	PE
22EE044	HYDROGEN GENERATION AND STORAGE	3	0	0	3	3	40	60	100	PE
VERTICAL V - EMBEDDED SYSTEM DESIGN										
22EE025	ADVANCED PROCESSOR ARCHITECTURES	3	0	0	3	3	40	60	100	PE
22EE026	COMMUNICATION PROTOCOLS AND STANDARDS	3	0	0	3	3	40	60	100	PE
22EE027	EMBEDDED C PROGRAMMING	3	0	0	3	3	40	60	100	PE
22EE028	REAL TIME OPERATING SYSTEMS	3	0	0	3	3	40	60	100	PE
22EE029	EMBEDDED LINUX	3	0	0	3	3	40	60	100	PE
22EE030	VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ELECTRICAL TECHNOLOGY										
22EE031	UTILIZATION OF ELECTRICAL ENERGY	3	0	0	3	3	40	60	100	PE
22EE032	INDUSTRIAL ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EE033	ILLUMINATION ENGINEERING	3	0	0	3	3	40	60	100	PE
22EE034	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	PE
22EE035	ENERGY AUDITING AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
22EE036	PLC AND SCADA	3	0	0	3	3	40	60	100	PE
22EE037	ARTIFICIAL INTELLIGENCE IN ELECTRICAL ENGINEERING	3	0	0	3	3	40	60	100	PE
22EE038	BIG DATA ANALYTICS FOR SMART GRID	3	0	0	3	3	40	60	100	PE
22EE039	INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE

22EE040	AUTOMOTIVE ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EE043	PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3	3	40	60	100	PE
22EE046	SENSORS AND WEARABLE TECHNOLOGY	3	0	0	3	3	40	60	100	PE

HONORS VERTICAL COURSES*									
VERTICAL III – ELECTRIC VEHICLE TECHNOLOGY									
22EEH13	ELECTRIC VEHICLE ARCHITECTURE	3	0	0	3	3	40	60	100	PE
22EEH14	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EEH15	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	3	0	0	3	3	40	60	100	PE
22EEH16	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	3	0	0	3	3	40	60	100	PE
22EEH17	GRID INTEGRATION OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EEH18	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EEH41	IoT FOR INDUSTRY AUTOMATION	3	0	0	3	3	40	60	100	PE
22EEH42	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE

HONORS VERTICAL COURSES**										
VERTICAL I - POWER SYSTEMS										
22EEH01	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
22EEH02	POWER QUALITY	3	0	0	3	3	40	60	100	PE
22EEH03	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
22EEH04	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22EEH05	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
22EEH06	POWER SYSTEM DEREGULATION	3	0	0	3	3	40	60	100	PE

MINOR VERTICAL COURSES*										
VERTICAL III – ELECTRIC VEHICLE TECHNOLOGY										
22EEM13	ELECTRIC VEHICLE ARCHITECTURE	3	0	0	3	3	40	60	100	PE
22EEM14	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE

22EEM15	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	3	0	0	3	3	40	60	100	PE
22EEM16	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	3	0	0	3	3	40	60	100	PE
22EEM17	GRID INTEGRATION OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EEM18	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
22EEM41	IoT FOR INDUSTRY AUTOMATION	3	0	0	3	3	40	60	100	PE
22EEM42	ROBOTICS AND AUTOMATION	3	0	0	3	3	40	60	100	PE

MINOR VERTICAL COURSES**										
VERTICAL I - POWER SYSTEMS										
22EEM01	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
22EEM02	POWER QUALITY	3	0	0	3	3	40	60	100	PE
22EEM03	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
22EEM04	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22EEM05	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
22EEM06	POWER SYSTEM DEREGULATION	3	0	0	3	3	40	60	100	PE

* Honor and Minor vertical courses offered for the students admitted during academic year 2023-2024 and 2024-2025.

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

ONE CREDIT COURSES										
22EE0XA	INTEGRATED CIRCUITS FOR POWER MANAGEMENT	1	0	0	1	-	100	0	100	EEC
22EE0XB	VISIONARY AUTOMATION	1	0	0	1	-	100	0	100	EEC
22EE0XC	SOLAR PV SYSTEM DESIGN AND IMPLEMENTATION	1	0	0	1	-	100	0	100	EEC
22EE0XD	LOW POWERED INDUSTRIAL EDGE AGENT	1	0	0	1	-	100	0	100	EEC
22EE0XE	INDUSTRIAL POWER SUPPLY DESIGN AND IMPLEMENTATION	1	0	0	1	-	100	0	100	EEC
22EE0XF	DESIGN OF POWER CONVERTER FOR INDUSTRIAL APPLICATIONS	1	0	0	1	-	100	0	100	EEC
22EE0XG	PCB FABRICATION OF POWER SEMICONDUCTOR DEVICES	1	0	0	1	-	100	0	100	EEC
22EE0XH	ADVANCED EMBEDDED SYSTEMS PROGRAMMING	1	0	0	1	-	100	0	100	EEC
22EE0XI	REAL TIME PROGRAMMING IN MULTICORE PROCESSOR	1	0	0	1	-	100	0	100	EEC
22EE0XJ	BATTERY ENERGY STORAGE SYSTEMS FOR MICROGRID	1	0	0	1	-	100	0	100	EEC
22EE0XK	IoT BASED AUTOMATION SYSTEMS FOR IRRIGATION	1	0	0	1	-	100	0	100	EEC

OPEN ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Wee**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE
22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
22OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	OE
22OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	OE
22OEI02	SENSOR TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE

22OME02	INDUSTRIAL PROCESS	3	0	0	3	3	40	60	100	OE
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	OE
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
22OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
22OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	OE
22OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	OE
22OPH04	BIOPHOTONICS	3	0	0	3	3	40	60	100	OE
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE
22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OGE02	ENTREPRENEURSHI P DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
22OGE03	ENTREPRENEURSHI P DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
22OGE04	NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE
22OAM01	COMPUTER VISION IN HEALTHCARE	3	0	0	3	3	40	60	100	OE
22OAM02	NEURAL NETWORKS	3	0	0	3	3	40	60	100	OE
22OAI01	FUNDAMENTALS OF DATA SCIENCE	3	0	0	3	3	40	60	100	OE
22OBM01	OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES	3	0	0	3	3	40	60	100	OE
22OBM02	AMBULANCE AND EMERGENCY MEDICAL SERVICE	3	0	0	3	3	40	60	100	OE
22OBM03	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	OE
22OAG01	RAINWATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OCB01	INTERNATIONAL BUSINESS MANAGEMENT	3	0	0	3	3	40	60	100	OE

22OCE02	COST MANAGEMENT OF ENGINEERING PROJECTS	3	0	0	3	3	40	60	100	OE

22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
1	1	2	-	-	-	-	-	-	-	-	-	-	-	1
2	2	2	-	-	-	-	-	-	-	-	-	-	-	1
3	2	1	-	-	-	-	-	-	-	-	-	-	-	1
4	2	2	-	-	-	-	-	-	-	-	-	-	-	1
5	1	2	-	-	-	-	-	-	-	-	-	-	-	1

UNIT I **9 Hours**

MATHEMATICS MODELING OF LINEAR FUNCTIONS

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

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

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

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

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

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

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

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

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

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, Khanna, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons2020
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018

22PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

CONSERVATION OF ENERGY

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

UNIT II **5 Hours**

VIBRATIONAL ENERGY

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

UNIT III **6 Hours**

PROPAGATION OF ENERGY

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

UNIT IV **7 Hours**

EXCHANGE OF ENERGY

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

UNIT V **6 Hours**

ENERGY IN MATERIALS

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

EXPERIMENT 1 **5 Hours**

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

EXPERIMENT 2 **5 Hours**

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

EXPERIMENT 3 **5 Hours**

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

EXPERIMENT 4 **5 Hours**

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

EXPERIMENT 5 **5 Hours**

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

EXPERIMENT 6 **5 Hours**

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

Reference(s) **Total: 60 Hours**

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

22CH103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

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

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

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

UNIT III **6 Hours**

CHEMICAL BONDING

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

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

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

UNIT V **6 Hours**

STATES OF MATTER

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

EXPERIMENT 1 **5 Hours**

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

EXPERIMENT 2 **5 Hours**

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

EXPERIMENT 3 **4 Hours**

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

EXPERIMENT 4 **5 Hours**

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

EXPERIMENT 5 **3 Hours**

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

EXPERIMENT 6 **4 Hours**

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

EXPERIMENT 7 **4 Hours**

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

Total: 60 Hours

Reference(s)

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020
2. Peter Atkins, Physical Chemistry, Oxford university press, 2019
3. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019
4. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017
6. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016

22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

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

PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **8 Hours**

CODES AND COMBINATIONS

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

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

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

UNIT III **11 Hours**

ASSEMBLY LANGUAGE PROGRAMMING

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

UNIT IV **9 Hours**

OPERATING SYSTEM AND APPLICATION GENERATION

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

UNIT V **8 Hours**

SOFTWARE DEVELOPMENT

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

Total: 45 Hours

Reference(s)

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

22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **15 Hours**

SELF-EXPRESSION

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

UNIT II **15 Hours**

CREATIVE EXPRESSION

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

UNIT III **15 Hours**

FORMAL EXPRESSION

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

Total: 45 Hours

Reference(s)

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

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **5 Hours**

ELECTRIC CHARGE

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

UNIT II **7 Hours**

ELECTRIC FIELD

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

UNIT III **7 Hours**

MAGNETIC FIELDS

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

UNIT IV **6 Hours**

FORCE ON CHARGES

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

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

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

EXPERIMENT 1 **7 Hours**

Analysis the behaviour of a Fixed Resistor in an Electric Heater

EXPERIMENT 2 **7 Hours**

Construct an Electrical Wiring Layout for a Basic Household Applications

EXPERIMENT 3 **8 Hours**

Analysis the Self and Mutual Induction in a Domestic Fan

EXPERIMENT 4 **8 Hours**

Design a Transistor based Electronic Switch

Total: 60 Hours

Reference(s)

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

22HS002 STARTUP MANAGEMENT 1 0 2 2

Course Objectives

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

Programme Outcomes (POs)

PO7.Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **3 Hours**
BUSINESS MODELS AND IDEATION
Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

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

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

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

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

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

UNIT V **3 Hours**

COMMERCIALIZATION

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

EXPERIMENT 1 **1 Hour**

Analysis of various business sectors

EXPERIMENT 2 **2 Hours**

Developing a Design Thinking Output Chart

EXPERIMENT 3 **1 Hour**

Creating Buyer Personas

EXPERIMENT 4 **3 Hours**

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**

Preparation of Business Model Canvas

EXPERIMENT 6 **15 Hours**

Developing Prototypes

EXPERIMENT 7 **2 Hours**

Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**

Preparation of Business Plans

EXPERIMENT 9 **2 Hours**

Preparation of Pitch Decks

Total: 45 Hours

Reference(s)

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

22HS003 HERITAGE OF TAMILS **1 0 0 1**

Course Objectives

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

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

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

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART- SCULPTURE

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

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

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

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

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

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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

Total: 15 Hours

Reference(s)

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

22HS003 - தமிழர் மரபு 1 0 0 1

பாடத்திட்டத்தின் ந ாக்கம்

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

கற்றலின் விளைவு

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

அலகு I மொழி மற்றும் இலக்கியம்: 3

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

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

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

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

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

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
1	1	2	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I 9 Hours

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT II 9 Hours

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT III 9 Hours

VECTOR DIFFERENTIAL CALCULUS

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

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

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

UNIT V **9 Hours**

COMPLEX FUNCTIONS

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

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B.Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

ELECTRICITY

Electric monopoles - Electric field- Electric flux - Electric potential - electrical energy- capacitor-Conductors and Insulators-Electric dipole and polarization - electric current -voltage sources- resistance

UNIT II **6 Hours**

MAGNETISM

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

UNIT III **6 Hours**

ELECTROMAGNETIC WAVES AND LIGHT

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

UNIT IV **6 Hours**

MODERN PHYSICS

Special theory of relativity - simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - de-Broglie hypothesis - wave nature of particles

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

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

EXPERIMENT 1 **5 Hours**

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

EXPERIMENT 2 **5 Hours**

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

EXPERIMENT 3 **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 4 **5 Hours**

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

EXPERIMENT 5 **5 Hours**

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

EXPERIMENT 6 **5 Hours**

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

Total: 60 Hours

Reference(s)

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

22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

ELECTROCHEMISTRY

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

UNIT II **6 Hours**

ENERGY STORING DEVICES

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

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

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

UNIT IV **6 Hours**

CATALYSIS

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

UNIT V **6 Hours**

NUCLEAR REACTIONS

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

EXPERIMENT 1 **4 Hours**

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

EXPERIMENT 2 **4 Hours**

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

EXPERIMENT 3 **4 Hours**

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

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

EXPERIMENT 5

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors. **4 Hours**

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application.

EXPERIMENT 7 **5 Hours**

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

Reference(s)

Total: 60 Hours

1. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, Wiley- VCH, 2017
2. S. Vairam, Engineering Chemistry, John Wiley &Sons, 2014
3. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
4. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th edition, (revised) New Age International Publishers, 2011
6. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

VISUAL PROCESS MODELING

Scenario decomposition - logical sequencing - drawing flowchart - preparing visual process model.

UNIT II **12 Hours**

ALGORITHMIC DESIGN THINKING

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

UNIT III **12 Hours**

DATA ORGANIZATION

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

UNIT IV **7 Hours**

DATA STORAGE

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

UNIT V **8 Hours**

NETWORKING ESSENTIALS

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

Total: 45 Hours

Reference(s)

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

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

ENERGY TRANSFER AND SIGNALS

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

UNIT II **8 Hours**

SIGNAL CONDITIONING USING DIODE

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

UNIT III **6 Hours**

SIGNAL CONDITIONING USING TRANSISTOR

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

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

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

UNIT V **4 Hours**

DEVICES FOR SPECIALREQUIREMENTS

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

EXPERIMENT 1 **6 Hours**

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

EXPERIMENT 2 **6 Hours**

Design and construct regulated DC power supply for Mobile phone charger

EXPERIMENT 3 **6 Hours**

Design and construct an audio amplifier circuit for amplifying the volume to play the mobile sound in a huge speaker.

EXPERIMENT 4 **6 Hours**

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

EXPERIMENT 5 **6 Hours**

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

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018).

22GE005 ENGINEERING DRAWING 1 0 2 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

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

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

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

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

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

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

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

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

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

Total: 45 Hours

Reference(s)

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

22HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I 15 Hours

SELF-EXPRESSIONRESSION

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

UNIT II 15 Hours

CREATIVE EXPRESSION

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

UNIT III **15 Hours**

FORMAL EXPRESSION

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

Total: 45 Hours

Reference(s)

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

22HSH01 HINDI **1 0 2 2**

Course Objective(s)

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

Programme Outcomes (POs)

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

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

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

VOWELS AND CONSONANTS

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

UNIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

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

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

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

UNIT V **9 Hours**

CONVERSATIONS

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

Total: 45 Hours

Reference(s)

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

22HSG01 GERMAN **1 0 2 2**

Course Objective(s)

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

Programme Outcomes (POs)

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

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

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

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

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

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

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

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

UNIT IV **9 Hours**

INTERROGATION

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

UNIT V **9 Hours**

IMPLEMENTATION

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

Total: 45 Hours

Reference(s)

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

22HSJ01 JAPANESE **1 0 2 2**

Course Objective(s)

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

Programme Outcomes (POs)

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

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

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

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

UNIT II **9 Hours**

TIME EXPRESSION / VERBS - PAST

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

UNIT III **9 Hours**

ADJECTIVES

Word Sentence-Introduction to Adjectives-Technical Japanese Vocabulary -Pair Activity Day to day - situational conversation-Listening to Japanese Alphabet Pronunciation-Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

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

UNIT V **9 Hours**

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

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

Total: 45 Hours

Reference(s)

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

22HSF01 FRENCH **1 0 2 2**

Course Objectives

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

Programme Outcomes (POs)

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

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

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

ENTRER EN CONTACT

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

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

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

UNIT III **9 Hours**

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

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

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

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

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite

Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

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

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objective(s)

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

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

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

3 Hours

UNIT II

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and

Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

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

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

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

UNIT V **3 Hours**

SCIENTIFIC TAMIL & TAMIL COMPUTING

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

Total: 15 Hours

Reference(s)

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

22HS006 - தமிழரும் ததாழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் ந ாக்கம்

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

கற்றலின் விளைவு

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

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

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

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

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

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

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

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

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

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

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

TOTAL : 15 PERIODS

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

22HS009 COCURRICULAR OR EXTRACURRICULAR ACTIVITY

Course Objectives

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

Programme Outcomes (POs)

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

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

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

Co-Curricular activity

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

Extracurricular activity

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

Total: 40 Hours

22EE301 COMPLEX INTEGRATION, TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

3 1 0 4

Course Objectives

- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.
- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

Programme Outcomes (POs)

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem Analysis: dentify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Apply the concepts of analytic function to estimate the integral in complex plane.
2. Analyze the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
3. Demonstrate a function in frequency domain whenever the function is defined in time domain using Fourier transforms.
4. Apply the concepts of Laplace transforms to convert functions in time domain to frequency domain.
5. Analyze the concept of partial differential equations to solve the problems in electrical field.

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**

COMPLEX INTEGRATION

Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent's series- Classification of Singularities - Cauchy's Residue Theorem.

UNIT II **9 Hour**

FOURIER SERIES

Introduction-Periodic Functions- Dirichlet's Conditions - General Fourier Series - Odd and Even Functions - - Parseval's Identity-Root Mean Square Value- Harmonic Analysis

UNIT III **9 Hours**

FOURIER TRANSFORM

Fourier Integral Theorem- Fourier Transform and Inverse Fourier Transform- Sine and Cosine Transforms - Properties - Transforms of Simple Functions - Convolution Theorem - Parseval's Identity

UNIT IV **9 Hours**

LAPLACE TRANSFORM

Laplace Transform: Existence of Laplace transform- Properties of Laplace Transform-Laplace Transform of Periodic Function. Inverse Laplace Transform: Properties of Inverse Laplace Transform- Partial Fraction Method-Convolution- Application of Laplace Transform to Ordinary Differential Equations with Constant Coefficients.

UNIT V **9 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of Partial Differential Equations of Second Order - Solution of: One Dimensional Wave Equation, One Dimensional Heat Equation, Two Dimensional Heat Equation.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil, Advanced Engineering Mathematics, 7th Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Pearson, 3rd edition 2014.
4. Michael D Greenberg., Advanced Engineering Mathematics, Pearson Education, 2nd Edition 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2015.

22EE302 CIRCUIT ANALYSIS 3 1 0 4

Course Objectives

- To apply basic laws in Circuits and to calculate the voltages and current in a circuit using basic theorems.
- To apply the concept of transients and resonance in series and parallel circuit.
- To develop two port networks and analysis different types of two port networks.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply Voltage-Current laws and transformation techniques to solve linear electric circuits and analyse the phase relationships of circuits with RLC components.
2. Evaluate the electrical parameters of the circuits by using network theorems.
3. Analyse the steady state and transient response of RLC circuit using Laplace transform.
4. Analyse the frequency response of an electric circuit.
5. Evaluate the driving point and transfer function of two port network and classify different two port network.

Articulation Matrix

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

UNIT I **10 Hours**

CIRCUIT LAWS AND ANALYSIS TECHNIQUES

Basic electrical components, Voltage - current laws, Divider theorem, Short and Open Circuits, Phase relationship for R, L and C, Impedance and Admittance for R, L and C, Mesh and Nodal Analysis for AC and DC circuits, Source transformation techniques, Star delta transformation techniques

UNIT II **9 Hours**

NETWORK THEOREMS FOR DC AND AC CIRCUITS

Superposition theorem – Thevenin's theorem – Norton's theorem - Maximum power transfer theorem - Reciprocity theorem.

UNIT III **8 Hours**

STEADY STATE AND TRANSIENT ANALYSIS OF AC AND DC CIRCUITS

Steady state and Transient analysis of RL, RC, RLC circuits using Laplace Transform for both AC and DC input.

UNIT IV **9 Hours**

RESONANCE AND MAGNETICALLY COUPLED CIRCUITS

Resonance: Natural frequency and Damping Ratio - Series Resonance - Parallel Resonance - Quality Factor. Coupled Circuits: Self-inductance- Mutual inductance - Dot conversion - Ideal Transformer.

UNIT V **9 Hours**

LINEAR TWO PORT NETWORK PARAMETERS

Driving point and transfer function of two port network, Z, Y, T, inverse T, Hybrid, Inverse Hybrid Parameters and its conversion.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. William Hayt, J V Jack, E Kemmerly and Steven M Durbin, Engineering Circuits Analysis, Tata McGraw-Hill, 2013.
2. Joseph Edminister and Mahmood Nahri, Theory and Problems of Electric Circuits Tata McGraw-Hill, 2008.
3. A Sudhakar, S Shyammohan and Palli, Circuits and Network (Analysis and synthesis) Tata McGraw-Hill, 2010.
4. L Robert Boylested, Experiments in Circuit Analysis to Accompany Introductory Circuit Analysis, PHI, 2002.
5. M. Russell, Mersereau and Joel R. Jackson, Circuit Analysis- A System Approach, Pearson Education, 2009.
6. Steven T. Karris, Circuit Analysis I with MATLAB Applications, Orchard Publications, 2004.

22EE303 ELECTRICAL MACHINES I 3 1 0 4

Course Objectives

- To understand the production of torque and EMF.
- To understand the construction, operation and characteristics of various types of DC machines.
- To understand the performance of single phase transformer
- To understand the performance of three phase transformers
- To estimate the construction, operation, starting and speed control of induction motor

Programme Outcomes (POs)

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze and apply DC machine design, performance, and control principles for practical applications.
2. Evaluate and apply single-phase transformer construction, operation, and testing for efficient power systems.
3. Analyze and apply three-phase transformer connections, phase relationships, and load sharing principles in power distribution.
4. Analyze and apply induction motor construction, torque, and slip characteristics for performance optimization.
5. Design and evaluate starting and speed control strategies for induction motors ensuring operational efficiency.

Articulation Matrix

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

UNIT I **10 Hours**

DC MACHINES

Generator and Motor- Construction - Principle of operation - Types - Characteristics - Armature reaction and commutation - Starting and Speed control -Various Testing –Applications.

UNIT II **9 Hours**

SINGLE PHASE TRANSFORMERS

Construction - Principle of operation - Types - Equivalent circuit -Voltage regulation and efficiency -Auto transformer- Testing of transformers -Polarity, open circuit, short circuit and Sumpner's test.

UNIT III **8 Hours**

THREE PHASE TRANSFORMER

Construction,Type of connections, Relation between line and phase voltages and currents, Scott connection of transformers for phase conversion, Parallel operation of transformer, on-load and off-load tap changing transformer.

UNIT IV **10 Hours**

INDUCTION MOTOR

Construction of three phase induction motor- Types of rotor - Operation - torque equation - Torque - slip characteristics - Equivalent circuit model - Double Revolving Field Theory - Methods of Starting: Capacitor start - Capacitor start capacitor run single phase induction motor.

UNIT V **8 Hours**

STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

Need for starters - Methods of starting - Fully automated starters: DOL, Autotransformer, star delta starter - rotor resistance starter - Methods of Speed Control - V/f Control and Pole Changing Techniques.

Tutorial : 15 Hours

Total: 60 Hours

Reference(s)

1. M.G.Say, Performance and Design of Alternating Current Machines, 3rd Edition, CBS Publisher, 2017.
2. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2018.
3. Stephen J.Chapman, Electric Machinery Fundamentals, Tata McGraw Hill, New Delhi, 2018.
4. E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, Electric Machinery, Tata McGraw Hill publishing Company Ltd, New Delhi ,2015.
5. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2018.

22EE304 ANALOG CIRCUITS AND SYSTEMS 3 0 2 4

Course Objectives

- To understand the fundamentals of BJT and Feedback amplifiers.
- To understand the characteristics, linear and Non-linear applications of Op-amp.
- To analyze the different types of opamp based Oscillators.
- To understand the operation of A/D and D/A converters using Op-amp and other special ICs.
- To familiarize the students with the PLDs and VHDL.

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the amplifier performance using feedback techniques for stability and noise reduction the biasing techniques and Amplifiers based on BJT.
2. Analyze the characteristics and develop simple circuits for various applications of the Op-amp.
3. Apply the non linear applications of op-amp in the design of simple waveform generators.
4. Analyse the various applications of Special ICs.
5. Evaluate the performance of logic circuits designed with different 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	-	-	2	-
2	3	3	1	1	-	1	-	-	2	2	-	-	2	1
3	3	3	-	1	-	1	-	-	2	2	-	-	2	1
4	2	2	2	1	-	1	-	-	2	2	-	-	2	1
5	2	3	2	1	2	-	-	-	2	2	-	-	2	1

UNIT I **9 Hours**

TRANSISTOR BIASING & FEEDBACK AMPLIFIERS

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

UNIT II **9 Hours**

OP-AMP CHARACTERISTICS & APPLICATIONS

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

UNIT III **9 Hours**

WAVEFORM GENERATORS

Barkhausen criterion - Oscillators using BJT: LC - Hartley, Colpitts and Crystal Oscillators - Principles of Op- Amp based Sine wave Oscillator - RC Phase Shift, Wien Bridge Oscillator – Multivibrators (Op-Amp & 555) - Astable, Monostable and Bistable.

UNIT IV **9 Hours**

COMPARATORS, DATA CONVERTERS AND SPECIAL FUNCTION ICS

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

UNIT V **9 Hours**

PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES

Programmable Logic Devices: PLA, PAL, Logic families: TTL, ECL, IIL, CMOS, Introduction to VHDL programming - Behavioural, Dataflow, and structural modeling - simple VHDL codes.

EXPERIMENT 1 **10 Hours**

Design and build a simple audio amplifier using Operational Amplifier /Transistor in Public Addressing System.

EXPERIMENT 2 **5 Hours**

Design and implementation of light detector using Operational amplifier.

EXPERIMENT 3 **5 Hours**

Design and implementation of ambulance siren circuit using Timer IC.

EXPERIMENT 4 **10 Hours**

Designing Calculator using VHDL Specifications (Addition, Subtraction)

Total: 75 Hours

Reference(s)

1. David A.Bell, 'Op-amp & Linear ICs', Oxford, 2013.
2. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, 2015.
3. Adel. S. Sedra , Kenneth C. Smith, Microelectronic Circuits Theory an Applications ,7th Edition, Oxford University, 2017.
4. Jacob Millman, C. Halkias and Satyabrata Jit Electronic Devices and Circuits, 4TH Edition, Tata McGraw- Hill, 2015.
5. Vaibbhav Taraate, “PLD Based Design with VHDL: RTL Design, Synthesis and Implementation”, first Edition, Springer 2017.

22EE305 DATA STRUCTURES AND ALGORITHMS 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

INTRODUCTION

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

UNIT II **7 Hours**

LINEAR LIST: STACKS, QUEUES AND LISTS

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

UNIT III **6 Hours**

SORTING AND SEARCHING

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

UNIT IV **5 Hours**

NON LINEAR LIST: TREES

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

UNIT V **6 Hours**

GRAPHS

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

EXPERIMENT 1 **4 Hours**

Design an MP3 player using singly linked list and its operations

EXPERIMENT 2 **3 Hours**

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

EXPERIMENT 3 **4 Hours**

Implementation of storing a web browser's history

EXPERIMENT 4 **4 Hours**

Interrupt handling in real-time systems

EXPERIMENT 5 **3 Hours**

Design a program to implement a phonebook using sorting

EXPERIMENT 6 **4 Hours**

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

EXPERIMENT 7 **4 Hours**

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

EXPERIMENT 8 **4 Hours**

Scanning a hierarchical file system directory structure

Total: 60 Hours

Reference(s)

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

22HS004 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

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

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

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

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

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

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

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

UNIT V **6 Hours**

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

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

Total: 30 Hours

Reference(s)

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

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

0 0 2 1

Course Objectives

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

Programme Outcomes (POs)

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT – I - SELF-EXPRESSION **10 Hours**

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

UNIT – II - CREATIVE EXPRESSION **10 Hours**

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

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

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

Total: 30 Hours

Reference(s)

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

22EE401 POWER GENERATION, TRANSMISSION AND DISTRIBUTION 3 1 0 4

Course Objectives

- To understand the various aspects and functioning of conventional power generators.
- To understand the various types of transmission system and develop the mathematical models for line parameters.
- To compute the voltage regulation and efficiency using line parameters. To subsume the string efficiency.
- To understand the different types of insulators and underground cables.
- To understand distribution systems and substation layouts.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze various types of power generation systems, their layouts, and their operational principles based on load factors.
2. Apply knowledge of transmission line parameters to evaluate resistance, inductance, and capacitance effects in single-phase and three-phase transmission lines.
3. Analyze the performance of transmission lines using ABCD constants, Ferranti effect, and corona losses.
4. Evaluate overhead lines and cables concerning insulators, voltage distribution, string efficiency, and capacitance grading.
5. Apply distribution system principles to analyze AC and DC distribution networks, substation equipment, and bus-bar arrangements.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	1	-	-	-	-	-	-	1	3	-
2	3	3	3	2	2	-	-	-	-	-	-	2	-	3
3	3	3	2	3	2	-	-	-	-	-	-	2	3	3
4	3	2	2	3	1	-	-	-	-	-	-	2	3	3
5	3	2	2	2	2	-	-	-	-	-	-	1	3	3

UNIT I **9 Hours**

POWER GENERATORS

Load curves-Power system factors-Power station choice and site selection-Steam power plants-Layout and working- Turbo-alternators-Hydroelectric power plants-Layout and working- Nuclear power plants-Layout and working.

UNIT II **9 Hours**

TRANSMISSION LINE PARAMETERS AND MODELING

Resistance, Inductance and capacitance of single phase and three phase line - Stranded and bundled conductor configurations - Symmetrical and unsymmetrical spacing - Transposition of line conductors - Double circuit lines -Skin and proximity effects.

UNIT III **9 Hours**

PERFORMANCE OF TRANSMISSION LINES

Regulations and Efficiency of Short Lines, Medium transmission lines by nominal T & Pi methods- Long Transmission line by Rigorous Solutions - ABCD Constant - Ferranti Effect - Corona Effect - Corona loss.

UNIT IV **9 Hours**

OVERHEAD LINES AND CABLES

Insulators - Types and comparison - Voltage distribution in insulator string - String efficiency - Methods of improving string efficiency- Sag in overhead lines- - Types - Capacitance - Grading of cables - Testing of cables

UNIT V **9 Hours**

DISTRIBUTION SYSTEMS

Primary and Secondary distribution networks-AC and DC distribution - single phase and three phase, 4-wire distribution- System comparison - Substation equipment and layouts - Bus bar arrangements.

Tutorial : 15 Hours
Total: 60 Hours

Reference(s)

1. B.R. Gupta Generation of Electrical Energy-7th edition, S.Chand Publishers, New Delhi,2017.
2. Leonard L. Grigsby , Electric Power Generation, Transmission, and Distribution, CRC Press, 2018.
3. Ailson P. de Moura, Adriano Aron F. de Moura, Ednardo P. da Rocha, Transmission of Electrical Energy-Overhead Lines, CRC Press, 2020.
4. I.J.Nagrath, D.P.Kothari, Power System Engineering, Tata McGraw Hill Ltd, New Delhi, 2017.
5. Kamaraju , Electrical Power Distribution Systems, Tata McGraw Hill Ltd, New Delhi, 2017.

22EE402 ELECTRICAL MACHINES II 3 0 2 4

Course Objectives

- To understand the production of torque and EMF in Synchronous machine.
- To understand the construction, operation and characteristics of PMSM and BLDC.
- To understand the operation and characteristics of Servo Motor and its applications.
- To understand the construction, operation and characteristics of SRM.
- To estimate the performance of Stepper motor and Linear Induction motor.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyse the characteristics and assess the performance of Synchronous Machines.
2. Analyze the characteristics and select a PMSM and BLDC motor for an Electric vehicle.
3. Apply the concept of servo mechanism and analyze the performance of Servo motor.
4. Analyze the performance of SRM and select a SRM drive for the industrial application.
5. Analyze the characteristics and select a Stepper motor for a robotics application.

Articulation Matrix

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

UNIT I **9 Hours**

SYNCHRONOUS MACHINES

Construction Details – Types of Rotor – Operation in Motor and Generating Mode – Torque and EMF Equation – Voltage Regulation in Generator – Direct Loading method – Synchronizing and Parallel Operation – Synchronous condenser.

UNIT II **9 Hours**

PMSM AND BLDC

Construction and principle of operation – Types - EMF and torque equations - torque speed characteristics - Hall sensors - optical position sensors –Driver circuits for PMSM and BLDC. Speed control of PMSM and BLDC. Selection of BLDC for E Vehicles.

UNIT III **9 Hours**

SERVO MOTOR

Servo Mechanism, Types of Servo Motors – DC and AC - Characteristics of servo motor – Selection of servo – Position Control –Servo Drives.

UNIT IV **9 Hours**

SWITCHED RELUCTANCE MOTORS

Constructional features - Principle of operation - Torque equation -Power controllers - Control circuits for SRM - - Microprocessor based control -Torque speed Characteristics –SRM Drives.

UNIT V **9 Hours**

STEPPER MOTOR

Construction and Principle of operation - Variable reluctance stepper motor, Permanent magnet stepper motor, Hybrid stepper motor, Static and dynamic characteristics, Driver circuit, Applications and advantages.

LABORATORY EXPERIMENTS

EXPERIMENT 1

Analysis of load characteristics of low power Generators at Renewable energy based power generating stations.

15 Hours

EXPERIMENT 2

Design and develop a closed loop control of servo motors in humanoid robots.

15 Hours

Total: 75 Hours

Reference(s)

1. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fifth Edition,2017.
2. Berker Bilgin , James Weisheng Jiang, Ali Emadi, “Switched Reluctance Motor Drives: Fundamentals toApplications”, CRC Press; 1st edition ,April 2019.
3. Riazollah Firoozian Servo Motors and Industrial Control Theory, Springer International. March 2021.
4. Duanek Hanselman, Brushless Motors: Magnetic Design, Performance, and Control of Brushless DC andPermanent Magnet Synchronous Motors, -Man Press LLC 2019.
5. Chang-liang Xia, Permanent Magnet Brushless DC Motor Drives and Controls, Wiley Publications, April 2012.

22EE403 MEASUREMENT AND INSTRUMENTATION 3 0 2 4

Course Objectives

- To understand the fundamental concepts of measuring instruments and Standards.
- To understand the operation of various analog and digital instruments.
- To infer the importance of various bridge circuits used for measuring electrical quantities.
- To understand the measurement of physical quantities such as temperature, pressure and flow.
- To learn the principle and working of various transducers and display devices.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze various types of errors in measurement and utilize statistical evaluation techniques to minimize their impact on measurement data.
2. Apply analog and digital measurement techniques to ensure accurate voltage, current, power and energy in electrical systems.
3. Design a suitable bridge for the measurement of unknown resistance, Inductance and Capacitance.
4. Analyze the operating characteristics of different transducers for real time applications.
5. Apply various display devices, including analog and digital CROs, mixed-signal oscilloscopes and event loggers, in real-time measurement 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	-	-	1	-
2	2	1	1	-	-	-	-	-	2	2	-	-	2	1
3	2	1	1	-	-	-	-	-	2	2	-	-	2	1
4	3	3	1	-	-	-	-	-	2	2	-	-	2	1
5	2	1	1	-	-	-	-	-	2	2	-	-	1	1

UNIT I 8 Hours

INTRODUCTION

Functional elements of an instruments, Static and dynamic characteristics, Errors in measurement, Techniques for reducing error, loading effect of instruments, Statistical evaluation of measurement data, Standards and calibration.

UNIT II **10 Hours**

ANALOG AND DIGITAL INSTRUMENTS

Analog Instruments **-**Moving coil instruments: Permanent magnet moving coil instruments, Moving iron: attraction and repulsion type instruments- Single and Three phase watt meters and Energy meters, Digital Instruments-Digital voltmeter, Digital multimeter, Energy meter.

UNIT III **9 Hours**

MEASUREMENT OF ELECTRICAL QUANTITIES

Measurement of Resistance: Kelvin double bridge, Wheatstone bridge, Measurement of inductance and capacitance: Maxwell, Anderson and Schering bridge, Earth Resistance Tester, Power Quality Analyzer.

UNIT IV **10 Hours**

TRANSDUCERS

Classification of transducers, Selection of transducers, Resistive, capacitive & inductive transducers, Piezoelectric and digital transducers, Measurement of Temperature: Thermocouples, Radiation and Optical pyrometer, pressure measurement, Flow measurement**-** ultrasonic and electromagnetic flow meter, pH measurement.

UNIT V **8 Hours**

DISPLAY DEVICES AND DATA ACQUISITION SYSTEMS

Analog CRO and Digital CRO, Mixed signal Oscilloscope, Time Synchronization, Recorders and event Loggers-Elements of Data Acquisition systems.

LABORATORY EXPERIMENTS

EXPERIMENT 1

Design and Develop a Digital Voltmeter for regulated power supply.

7 Hours

EXPERIMENT 2

Design and develop Light detector using Wheatstone Bridge for street light monitoring system.

8 Hours

EXPERIMENT 3

Design and develop a Digital Energy Meter for Residential Energy Monitoring.

7 Hours

EXPERIMENT 4

Design and develop a temperature monitoring system in an Air Conditioning room. **8 Hours**

Total: 75 Hours

Reference(s)

1. A. K. Sawhney, A Course in Electrical & Electronic Measurements & Instrumentation, 19th edition DhanpatRai and Co, 2014.
2. Alan Morris, Reza Langari, Measurement and Instrumentation Theory and Application, Elseveir Publications,2020.
3. Sergey Yurish, Advances in Measurement and Instrumentation reviews, IFSA publishing,2019
4. Robert B Northrop, Instrumentation and measurements, Taylor and Francis,2014.
5. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill, 3rd edition 2018.

22EE404 DIGITAL LOGIC CIRCUIT DESIGN 3 0 2 4

Course Objectives

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

Programme Outcomes (POs)

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

PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

NUMBER SYSTEMS AND CODES

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

UNIT II **10 Hours**

BOOLEAN THEOREMS AND LOGIC REDUCTION

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

UNIT III **10 Hours**

COMBINATIONAL LOGIC CIRCUITS

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

UNIT IV **10 Hours**

SEQUENTIAL LOGIC CIRCUITS

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

UNIT V **9 Hours**

COUNTERS, LOGIC FAMILIES AND PLDS

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

EXPERIMENT 1 **2 Hours**

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

EXPERIMENT 2 **3 Hours**

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

EXPERIMENT 3 **5 Hours**

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

EXPERIMENT 4 **5 Hours**

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

EXPERIMENT 5 **5 Hours**

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

EXPERIMENT 6 **5 Hours**

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

EXPERIMENT 7 **5 Hours**

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

Total: 75 Hours

Reference(s)

1. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.
2. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
3. A.Anand Kumar, Fundamentals of Digital Circuits, 4th Edition PHI Learning Private Limited, 2016.
4. Charles H. Roth, Jr., Fundamentals of Logic Design, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US,2014.
5. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009.

22EE405 EMBEDDED SYSTEMS 3 0 2 4

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

8086 MICROPROCESSOR

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

UNIT II **9 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

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

UNIT III **9 Hours**

TIVA-C MICROCONTROLLER & PROGRAMMING IN C

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

UNIT IV **9 Hours**

COMMUNICATION PROTOCOLS

UART, ADC, PWM, Timer, I2C, SPI.

UNIT V **9 Hours**

OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING

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

EXPERIMENT 1 **4 Hours**

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

EXPERIMENT 2 **4 Hours**

Design a display system for hotel using 8086 microprocessor.

EXPERIMENT 3 **5 Hours**

Design a ranking system for students using 8086 microprocessor

EXPERIMENT 4 **5 Hours**

Design a traffic light controller using TIVA-C microcontroller.

EXPERIMENT 5 **6 Hours**

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

EXPERIMENT 6 **6 Hours**

Design server room temperature monitoring system using TIVA-C microcontroller.

Total: 75 Hours

Reference(s)

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

22HS007 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

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

Programme Outcomes (POs)

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Examine the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Impact 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	-	-	-	-	-	-	-	-	-	-	-	1
2	1	1	-	-	-	-	-	-	-	-	-	-	-	1
3	2	2	-	-	-	-	1	-	-	-	-	-	-	1
4	1	-	-	-	-	-	-	-	-	-	-	-	-	1
5	2	-	-	-	-	-	-	-	-	-	-	-	-	1

UNIT I **6 Hours**

NATURAL RESOURCES

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

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

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

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

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

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

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

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

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

Total: 30 Hours

Reference(s)

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

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION 0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing.
- Effectively use the language to persuade others.
- Appreciate the nuances of the language and engage an audience.
- Use advanced tools of language to improve communicative competence.
- Prepare for professional demands at the workplace.
- Give concrete expression to the plans and goals.

Programme Outcomes (POs)

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes

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

Articulation Matrix

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

UNIT – 1 - CREATIVE EXPRESSION **15 Hours**

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

UNIT 2 - FORMAL EXPRESSION **15 Hours**

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

Total: 30 Hours

Reference(s)

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

22HS010 SOCIALLY RELEVANT PROJECT 0 0 2 0

Course Objectives

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

Program Outcomes

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary Tools.

Course Outcomes:

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

Articulation Matrix

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

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

Total: 40 Hours

22EE501 POWER SYSTEM ANALYSIS 3 0 2 4

Course Objectives

- To apply the concept of per unit systems in power system computations.
- To develop algorithms for power system planning.
- To understand the application of power system matrices.
- To understand the concept of symmetrical components.
- To analyze the stability of given network.

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the concept of per unit systems to construct the reactance diagram and develop the network matrices of the power system network.
2. Evaluate the power flow and losses in a power system network using non-linear iterative solution methods for power system planning.
3. Apply the concepts of bus impedance matrix and reactance diagrams to predict the effects of balanced faults in power system.
4. Apply the concept of symmetrical components to estimate the effects of unbalanced faults in power system for power system protection.
5. Evaluate the stability of the power system during transient operations.

Articulation Matrix

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

UNIT I **9 Hours**

POWER SYSTEM MODELING

Single line diagrams -Per unit system -Per unit impedance/ reactance diagrams -Formation of network matrices - Y bus formation using inspection and singular transformation -Z bus formation using step-by-step building algorithm method.

UNIT II **8 Hours**

LOAD FLOW ANALYSIS

Bus classification - Load flow equations and methods of solution -Slack bus concept -Gauss Seidal, Newton Raphson, Fast decoupled methods for load flow studies.

UNIT III **9 Hours**

FAULT ANALYSIS - SYMMETRICAL FAULTS

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin's theorem - Z-bus building algorithm - fault analysis using Z-bus - computations of short circuit capacity, post fault voltage and currents – Selection of Circuit breakers.

UNIT IV **10 Hours**

FAULT ANALYSIS - UNSYMMETRICAL FAULTS

Introduction to symmetrical components - sequence impedances - sequence circuits of synchronous machine, transformer and transmission lines - sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus matrix - Indian Standards for Short Circuit analysis IS- 13234.

UNIT V **9 Hours**

POWER SYSTEM STABILITY

Steady state and transient stability -Swing equation and its solution method (Runge – Kutta Method) -Equal area criterion -Factors affecting stability and methods of improving stability.

EXPERIMENT 1 **7 Hours**

To convert the given transmission line data to matrix format suitable for performing load flow analysis and fault analysis

EXPERIMENT 2 **9 Hours**

To analyze the uncertain conditions in planning a transmission network

EXPERIMENT 3 **7 Hours**

To estimate the cost required for power generation to satisfy the given power demand

EXPERIMENT 4 **7 Hours**

Analyze the fault clearing time in a power system network following a large disturbance in a transmission network to select the operating times of relay and circuit breaker.

Total: 75 Hours

Reference(s)

1. I.J. Nagarath, D.P. Kothari, Modern Power System Analysis, Tata McGraw Hill Publishing Company, New Delhi, 2022.
2. J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, Power System Analysis and Design, Cengage Learning, 2019.
3. Hadi Saadat, Power System Analysis, PSA Publishers, New Delhi, 2013.
4. P.Kundur, Om P. Malik, Power System Stability and Control, Tata McGraw Hill Book Company, New Delhi, 2022.
5. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, Electrical Power Systems Analysis, Security and Deregulation, PHI Learnin Private Limited, New Delhi, 2017.

22EE502 POWER ELECTRONICS 3 0 2 4

Course Objectives

- To analyze the static and switching characteristics of power semi-conductor devices.
- To understand the operation of controlled rectifiers.
- To understand and analyze the various types of choppers.
- To evaluate the operation, characteristics and performance parameters of Inverters.
- To understand the operation of ac-ac converters.

Programme Outcomes (POs)

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Assess the static and dynamic characteristics of power semiconductor devices with the protection circuits.
2. Evaluate the input and output parameters of controlled rectifiers with R, RL and RLE Load.
3. Apply the various converter topologies to design and analyze the switched mode regulators
4. Analyze the operation of inverter topologies with different PWM schemes.
5. Analyze the performance parameters of AC- AC converters.

Articulation Matrix

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

UNIT I **9 Hours**

POWER SEMI-CONDUCTOR DEVICES

Construction - Operation - Static and Dynamics characteristics of Power Diode- SCR-DIAC - TRIAC- GTO - Power BJT - MOSFET – IGBT- Ratings of Devices - Protection of Devices.

UNIT II **9 Hours**

CONTROLLED RECTIFIERS

Single Phase and Three Phase Half and Fully controlled rectifier with R, RL, RLE Load - Effect of Freewheeling Diode -Continuous and Discontinuous Mode of operation - Performance Analysis - Dual converter-Applications.

UNIT III **9 Hours**

CHOPPERS

Classification - Control strategies – Switches Mode Regulators – Non Isolated DC-DC Converters: Buck, Boost, Buck-Boost and Sepic Converters- Isolated DC-DC Converters: Flyback and Forward Converters-Performance analysis - Applications.

UNIT IV **10 Hours**

INVERTERS

Single Phase inverters and Three Phase Voltage Source Inverters - Single phase and Three Phase Current Source Inverters – Multilevel inverter-Types-Performance analysis - PWM techniques-Space Vector PWM Techniques - Analysis of Harmonic Distortion- Applications.

UNIT V **8 Hours**

AC-AC CONVERTERS

Single Phase and Three Phase AC Voltage Controllers-Performance Analysis - Matrix converters-Applications.

EXPERIMENT 1

Design a Lamp Dimmer circuit by selecting a suitable power electronic switch. **7 Hours**

EXPERIMENT 2

Design a power electronic converter for a solar PV system for driving a DC load of mobile phone charger circuit. **8 Hours**

EXPERIMENT 3

Speed Control of DC motor using half controlled bridge converter. **7 Hours**

EXPERIMENT 4 **8 Hours**

Analyze the three phase PWM inverter for motor load.

Total: 75 Hours

Reference(s)

1. Muhammad H.Rashid, ‘Power Electronics Circuits, Devices & Applications’, 4th Edition, Pearson India, 2018.
2. Ned Mohan, Tore. M. Undeland, William. P. Robbins, ‘Power Electronics: Converters, Applications and Design’, 3rd Edition Wiley India, NewDelhi, 2012.
3. M.D.Singh & K.B Khanchandani, ‘Power Electronics’, 2nd Edition, Tata Mc Graw Hill Publishing Co.Ltd., New Delhi, 2017.
4. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
5. José Rodríguez, , Jih-Sheng Lai, and Fang Zheng Peng, ‘Multilevel Inverters: A Survey of Topologies, Controls, and Applications’, IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2002.

22EE503 OPTIMIZATION IN ENGINEERING DESIGN

3 1 0 4

Course Objectives

- To understand the fundamentals of various techniques in optimization.
- To understand the optimization algorithms for single variable.
- To learn the multivariable optimization in engineering design.
- To know the concepts of multi objective and constrained optimization.
- To apply the knowledge of optimization in electrical engineering.

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply optimization techniques for solving single variable design problems.
2. Apply the concept of mathematical models to solve multi variable optimization problems.
3. Evaluate the transformation methods to give solutions to constrained optimization problem.
4. Apply optimization techniques to demonstrate multi objective optimization
5. Select and apply suitable techniques to solve optimization problems.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Optimal Problem Formulation: Design variables, Constraints, Objective function, Variable bounds, Classification of optimization algorithms, Single -variable optimization algorithms- Optimality criteria. Bracketing methods; Exhaustive search method, Bounding phase method. Region Elimination methods; Interval Halving Method, Fibonacci Search method.

UNIT II **9 Hours**

MULTI VARIABLE OPTIMIZATION

Optimality criteria, Unidirectional search, Direct Search methods- Box' Evolutionary Optimization method, Simplex Search method. Gradient based methods- Cauchy's (Steepest Descent) Method, Newton's Method.

UNIT III **9 Hours**

CONSTRAINED OPTIMIZATION ALGORITHMS

Kuhn- Tucker Conditions, Transformation Methods- Penalty function method and Method of multipliers. Sensitivity analysis, Direct search for constrained minimization; variable elimination method, complex search method, Random search method, Generalized reduced gradient method, Gradient projection method.

UNIT IV **9 Hours**

MULTI OBJECTIVE OPTIMIZATION PROBLEMS

Basic concepts – Non dominated solutions – preferences structure, basic solution approach – Weighted sum approach, Random weight approach, adaptive weight approach. Distance method, concepts – calculation of distance. Compromise approach and goal programming approach.

UNIT V **9 Hours**

OPTIMIZATION APPLICATIONS

Case study- Distance optimization, Transmission loss minimization, Machine dimension optimization.

Tutorial : 15 Hours

Reference(s)

Total: 60 Hours

1. Rao, S.S., "Engineering Optimization Theory and Practice ", Wiley Online Library., Fifth Edition,2019.
2. K. Deb, "Optimization for Engineering Design – Algorithms and Examples", Prentice-Hall of India Pub., 2012
3. Donald A. Pierre.,"Optimization Theory with Applications", Courier Corporation, 2012
4. Ashok D. Belegundu, Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering" , Cambridge University Press, 2019.
5. Joaquim R. R. A. Martins and Andrew Ning. "Engineering Design Optimization", Cambridge University Press, 2021.

22EE504 CONTROL SYSTEMS 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
2. Analyze the performance of first and second order system and compute the steady state error using different test signals.
3. Analyze the frequency response of a given system and comment the stability.
4. Analyze the stability of a given system using Routh Hurwitz criterion, Nyquist stability criterion and Root Locus techniques.
5. Apply the concept of lag, lead and lag lead compensator for open loop system and examine a system using state variable techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
3	3	3	-	2	-	-	-	-	-	-	-	-	3	-
4	3	3	-	2	-	-	-	-	-	-	-	-	3	-
5	3	3	1	2	-	-	-	-	-	-	-	-	3	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, Electrical analogy of mechanical systems Block diagram reduction techniques Signal flow graphs.

UNIT II **9 Hours**

TIME DOMAIN ANALYSIS

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

UNIT III **8 Hours**

FREQUENCY DOMAIN ANALYSIS

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

UNIT IV **10 Hours**

STABILITY ANALYSIS OF CONTROL SYSTEM

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

UNIT V **9 Hours**

COMPENSATOR DESIGN AND STATE VARIABLE ANALYSIS

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

Tutorial : 15 Hours

Total: 60 Hours

Reference(s)

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

22EE507 MINI PROJECT I 0 0 2 1

Course Objectives

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

ProgrammeOutcomes (POs)

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

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

22EE601 POWER SYSTEM PROTECTION AND SWITCH GEAR 3 0 0 3

Course Objectives

- To understand the different types of protection schemes in power system
- To understand the construction and operating principle of protective relays
- To gain knowledge on transmission line and apparatus protection schemes
- To understand the concept of arc phenomena, arc interruption and lightning arresters
- To illustrate the construction and operating principle of circuit breakers

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the different types of faults and protection schemes in power systems.
2. Analyze the operation of protective relays for effective power system protection.
3. Apply suitable protective schemes for electrical apparatus.
4. Apply the arc interruption schemes in Circuit Breakers.
5. Analyze the performance of different types of circuit breakers in electrical systems.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO PROTECTION SCHEMES

Principles and need for protective schemes, Nature and causes of faults, primary and backup protection, Electromagnetic relays, Comparison between static and electromagnetic relays, Step and Touch potential, Zones of protection, Power System Earthing.

UNIT II **10 Hours**

PROTECTIVE RELAY

Non directional and directional over current relays, Static and numerical over current relays, Distance relay - Impedance, reactance and mho relays, Differential and pilot relaying schemes, Auto reclosing and synchronizing.

UNIT III **9 Hours**

APPARATUS AND LINE PROTECTION

Alternator, transformer, induction motor, bus bar and feeder protection schemes, CTs and PTs and their applications in protection schemes, microprocessor based protective schemes

UNIT IV **8 Hours**

THEORY OF CIRCUIT INTERRUPTION

Physics of arc phenomena and arc interruption, Restriking voltage, Recovery voltage, rate of rise of restriking voltage, resistance switching, current chopping and interruption of capacitive current, lightning arresters and its types.

UNIT V

CIRCUIT BREAKERS **10 Hours**

Introduction- Rating of Circuit Breakers, Types of Circuit Breakers-Miniature, Earth leakage, Air blast, Air break, oil, SF6 and Vacuum circuit breakers with advantages and disadvantages, High voltage dc circuit breakers- Maintenance and Testing of circuit breakers-Recent developments in protective relays.

Total: 45 Hours

Reference(s)

1. Badri Ram, D.N.Viswakarma "Power system Protection and switchgear", Tata Mcgraw Hill, Private Limited, New Delhi, 2013.
2. Bhaveshbhalja, R.P. Maheshwari, Nilesh G. Chothani, "Protection and Swtichgear", Oxford University press, 2014.
3. Sunil S. Rao, "Switchgear Protection and Power Systems", Khanna publishers, New Delhi, 13th Edition, Reprint 2008.
4. V.K.Metha and Rohit Metha "Principles of power system", S. Chand company Ltd, 2011.
5. Wadhwa C L, "Electrical Power Systems", New age International (P) Ltd., Sixth Edition, 2010.
6. Bo, Z.Q., Lin, X.N., Wang, Q.P. et al. Developments of power system protection and control(2016).

22EE602 DIGITAL SIGNAL PROCESSING 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **10 Hours**

SIGNALS AND SYSTEMS

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

UNIT II **9 Hours**

DISCRETE TIME SYSTEM ANALYSIS

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

UNIT III **8 Hours**

DISCRETE FOURIER TRANSFORM

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

UNIT IV **10 Hours**

DESIGN OF FIR DIGITAL FILTERS

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

UNIT V **8 Hours**

DESIGN OF IIR DIGITAL FILTERS

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

Tutorial : 15 Hours

Total: 60 Hours

Reference(s)

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

22EE603 RENEWABLE AND DISTRIBUTED ENERGY SOURCES 3 0 2 4

Course Objectives

- To Understand the Conventional and non-conventional energy resources.
- To impart knowledge on solar and wind energy harvesting in various forms and its technologies.
- To explore the processes in bioenergy conversion system and other renewable energy sources.
- To Familiarize the concept of distributed generation and installation.
- To Analyze the impact of grid integration of Renewable energy sources.

Programme Outcomes (POs)

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

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

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

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

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

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

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

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the energy scenario and its impact on economic and social development.
2. Analyze the performance of different solar and wind energy systems with various measurement techniques and factors affecting them.
3. Apply the energy conversion techniques in bioenergy and other renewable energy systems.
4. Assess the impact of optimal DG placement in distribution networks.
5. Analyze the grid integration with conventional and non-conventional energy resources

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Energy scenario: global and national energy scenario. Renewable Energy potential: Global and national. Classification of RE technologies: Stand alone, grid connected and hybrid - Renewable Energy Scenario in India and around the World - Role of energy in economic development and social transformation, Government policies and schemes to promote renewable energy implementations.

UNIT II **9 Hours**

SOLAR AND WIND ENERGY

Solar Radiation - Measurements of Solar Radiation - Flat Plate and Concentrating Collectors - Solar heating and cooling techniques - Solar thermal plant - Solar Photovoltaic - Solar Cells and Modules-Types- factors affecting solar power generation - Solar PV Applications- Wind Data and Energy Estimation - site selection - wind resource assessment - Types of Wind Energy Systems - factors influencing wind - wind shear - Safety and Environmental factors.

UNIT III **9 Hours**

BIOENERGY AND OTHER RENEWABLE ENERGY SOURCES

Biomass resources and their classification - biomass direct combustion-biomass gasifiers - Biomass conversion processes - Biogas plants - Digesters - Ethanol production - Biodiesel - Cogeneration - Electricity generation through biomass and biogas Systems-Hydropower - Types, site selection, construction.-Geothermal energy - site selection, geothermal power plants. Hydrogen energy storage system - Fuel cell - types - construction and applications

UNIT IV **9 Hours**

DISTRIBUTED GENERATIONS (DG)

Concept of distributed generations-topologies-selection of sources– Current scenario in distributed generation – Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems- Energy Storage elements: Batteries, ultra-capacitors, flywheels- capacitive power plants.

UNIT V **9 Hours**

CHALLENGES WITH GRID INTEGRATION

Requirements for grid interconnection- limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability-stability and power quality issues.

Total: 45 Hours

EXPERIMENT 1

Forecasting of solar irradiance temperature and wind velocity using weather monitoring station. **6 Hours**

EXPERIMENT 2

Performance evaluation of solar water pumping system. **6 Hours**

EXPERIMENT 3

Performance evaluation of natural convection solar dryer with different food processing. **6 Hours**

EXPERIMENT 4

Design of solar PV boost converter using MPPT technique. **6 Hours**

EXPERIMENT 5

Design and simulation of Solar PV-wind hybrid system.. **6 Hours**

Total: 75 Hours

Reference(s)

1. D.P Kothari, K. C Singal, Rakesh Ranjan, Renewable energy sources and emerging technologies, PHI Learning Pvt. Ltd 2013.
2. S.P Sukhatme, J.K Nayak, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2014.
3. G.N. Tiwari, Solar Energy - Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2012.
4. Solanki, Solar Photovoltaics: Fundamental Technologies and Applications, Prentice-Hall of India Pvt.Limited, 3rd Edison, 2015.
5. Priscila Goncalves Vasconcelos Sampaio & Mario Orestes Aguirre Gonzalez, "Photovoltaic solar energy: Conceptual framework", Renewable and Sustainable Energy Reviews Volume 74, July 2017.

22EE607 MINI PROJECT II

0 0 2 1

Course Objectives

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

ProgrammeOutcomes (POs)

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

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints

Course Outcomes (COs)

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

Articulation Matrix

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

22EE701 ELECTRIC VEHICLE TECHNOLOGY 3 0 0 3

Course Objectives

- To understand the drive train of electric vehicle and different types of electric vehicles
- To understand the operation of various motors used for propulsion in electric vehicles.
- To categorize battery storage technologies used in electric vehicle system.
- To understand the fuel cells for energy storage in electric vehicles.
- To explore the modelling method of an electric two wheelers.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the power train components and different types of electric vehicles.
2. Assess the characteristics of various electrical drive system used for electric vehicles.
3. Apply the suitable battery technology and charging structure for an electric vehicle.
4. Analyze the performance of fuel cell energy storage system for an electric vehicle.
5. Analyze the modelling of vehicle acceleration and different EV range.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Importance and need of the electric vehicle (EV)- Comparative study on IC engine vehicles and electric vehicles-Overview of Electric Vehicle in India-Power train in electric vehicle: motors, controllers, battery, sensors-Types of EVs- Pure EVs, Plug-in EVs, Hybrid EVs, Plug-in Hybrid EVs, Fuel Cell EVs-Overview of Tesla Car.

UNIT II **9 Hours**

DRIVE SYSTEM FOR EVs

Configuration and control of Brushed and brushless DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor for EVs- Regenerative Braking in EVs-Drive system efficiency.

UNIT III **10 Hours**

BATTERY TECHNOLOGY FOR EVs

Types of batteries-Characteristics of Electric vehicle Battery-Lead Acid battery-Lithium Ion battery -Ah rating-C-rate-Charging and discharging characteristics- Charger requirements-Types of charging methods-Battery Management System- EV charging standards, V2G, G2V, V2B, V2H.

UNIT IV **9 Hours**

FUEL CELLS FOR EVs

Fuel cell: Introduction, Technologies & Types, Obstacles- Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

UNIT V **9 Hours**

ELECTRIC VEHICLE MODELLING

Tractive force of EV- Modelling Vehicle Acceleration: Electric Scooter Acceleration-Modelling EV Range: Driving cycles, Battery EV range modelling, Hybrid EV range modelling.

Total: 45 Hours

Reference (s)

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2012.
2. https://onlinecourses.nptel.ac.in/noc21_ee112/course.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, Taylor & Francis, CRC Press, 2018.
4. Akash Kumar Bhoi, Jens Bo Holm-Nielsen, Nil Patel, Sanjeevikumar Padmanaban,” Electric Vehicles: Modern Technologies and Trends”, Springer Nature Singapore, 2021.
5. Bruno Scrosati, Jurgen Garche, Werner Tillmetz, “Advances in Battery Technologies for ElectricVehicles”,Elsevier Science, 2015.

22EE702 INDUSTRIAL DRIVES AND AUTOMATION 3 0 2 4

Course Objectives

- To explore the various AC and special machine drives for industrial applications.
- To study the various open loop and closed loop control schemes for drives.
- To understand the fundamental concepts of industrial automation.
- To understand the communication protocols and ladder logic programming in PLC.
- To introduce the hardware implementation of the basic controllers using PLC.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the various speed control techniques with converter topologies to control the AC drives.
2. Select the suitable special drives for open / closed loop control applications.
3. Apply the interfacing method to connect a suitable I/O device with PLC module for the given application.
4. Analyze the PLC Timer & Counter functions for controlling sensors and actuators.
5. Analyze a PLC ladder program for real-time control applications.

Articulation Matrix

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

UNIT I **9 Hours**

AC DRIVES

Three phase induction motor – control methods – PWM inverter drives – VSI, CSI fed induction motor drives - Harmonic behavior - Rotor slip power recovery schemes. Synchronous motor – vector control – Open loop v/f control - load commutated Inverter control – VSI, CSI fed synchronous motor - Margin angle control and power factor control - Permanent magnet (PM) synchronous motor.

UNIT II **8 Hours**

SPECIAL DRIVES

Switched Reluctance Motor drive – Performance prediction – Control of SRM drive – Sensor less operation of SRM – Brushless DC motor drives - Variable reluctance and permanent magnet stepper motor Drives - Selection of drives and control schemes in industries - PLL, PID based control of drives –Closed loop control – sensor less BLDC motor control using PIC Controller.

UNIT III **9 Hours**

INDUSTRIAL AUTOMATION

Need and benefits of Industrial Automation, Automation Hierarchy, Basic components, Types. PLC Fundamentals - Building blocks, CPU, Memory organization, Input output modules (discrete and analog). Special I/0 Modules, Power supply, Fixed and Modular PLC – types, Redundancy, I/0 module selection, Interfacing different 1/0 devices with appropriate I/0 modules.

UNIT IV **9 Hours**

PLC BASED CONTROL

Bit logic instructions, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions, Control components, sensors, actuators and valves, PID configuration, various network topologies and communication protocols like Profibus, Foundation field bus, Devicenet, HART.

UNIT V **10 Hours**

PLC PROGRAMMING AND APPLICATIONS

PLC I/0 addressing, programming Instructions – PLC programming language, Functional Block Diagram (FBD). Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming, Ladder Logic for Automatic street light controller, Automatic agriculture irrigation system, Railway gate automation, Home automation, Bottle filling station.

EXPERIMENT 1

Select the I/O ports and configure a PLC with HMI to develop a control structure for an application.

10 Hours

EXPERIMENT 2

Develop a ladder program to sense and control various devices using PLC for the given application.

10 Hours

EXPERIMENT 3

Develop a ladder program in PLC for close loop control of the special drive and variable frequency drive.

10 Hours

Total : 75 Hours

Reference(s)

1. Vijay R Jadhav, Programmable Logic Controller, Khanna publishers, New Delhi, 3rd Edition, 2017.
2. John W Webb, Ronald A Reis, Programmable Logic Controllers, Principles and Applications, Pearson Education, PHI, 5th Edition, 2016.
3. Mitra. Madhuchandra; Sengupta, Samarjit, Programmable logic controllers and Industrial automation, An Introduction, Penram International Publication, New Delhi, 5th Reprint, 2015.
4. Haitham Abu-Rub, Atif Iqbal, Jaroslaw Guzinski, High Performance Control of AC Drives with Matlab / Simulink Models, John Wiley & Sons Ltd, Publications, 2nd Edition, 2021.
5. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, Taylor and Francis, CRC Press, 1st Edition, 2017.

22EE707 PROJECT WORK I 0 0 4 2

Course Objectives

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

ProgrammeOutcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of

Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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 the oral demonstrations.

Articulation Matrix

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

22EE801 PROJECT WORK II

0 0 20 10

Course Objectives

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

ProgrammeOutcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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 the oral demonstrations.

Articulation Matrix

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

PROFESSIONAL ELECTIVES

VERTICAL I – POWER SYSTEMS

22EE001 POWER SYSTEM OPERATION AND CONTROL 3 0 0 3

Course Objectives

- Understand the application of load forecasting tools.
- Understand the real power-frequency relationship and the need for developing the mathematical model of Load Frequency Control Loop.
- Understand the reactive power-voltage relationship and the necessity of voltage compensation.

Programme Outcomes (POs)

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Apply the load forecasting tools to estimate the generation and reserve capacity
2. Apply the concept of Laplace transform to construct the transfer function model of isolated and interconnected systems.
3. Apply various excitation systems and voltage control methods in power generation and transmission networks.
4. Apply the iterative techniques to determine economical operating point of generating units
5. Analyze the functions of load dispatch centers at National, Regional and State Levels.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation- Reserve requirements: Installed reserves, spinning reserves, cold reserves and hot reserves. Overview of system operation: Load forecasting, unit commitment and load dispatching. Overview of system control, Need for voltage and frequency regulation in power system, Plant level and System level controls.

UNIT II **10 Hours**

REAL POWER - FREQUENCY CONTROL

Fundamentals of speed governing mechanism and modeling: Speed-load characteristics-Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis. Multi-area systems: Two-area system modeling; static analysis; tie line with frequency bias control of two- area system. State variable model.

UNIT III **9 Hours**

REACTIVE POWER VOLTAGE CONTROL

Typical excitation system, modeling, static and dynamic analysis, stability compensation; generation and absorption of reactive power: Relation between voltage, power and reactive power at a node – method of voltage control - tap- changing transformer - System level control using generator voltage magnitude setting - tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT IV **9 Hours**

POWER SYSTEM ECONOMICS

Incremental cost curve, Unit Commitment and its constraints, Solution to unit commitment problem using priority list method- Economic Dispatch - co-ordination equations without loss and with loss, solution by direct method and lambda iteration method. (No derivation of loss coefficients.) Base point and participation factors. Economic dispatch controller added to LFC control.

UNIT V **8 Hours**

COMPUTER CONTROL OF POWER SYSTEMS

Energy control centre: Functions, Monitoring, data acquisition and control. System hardware configuration - SCADA and EMS functions: Network topology determination, security analysis and control. Various operating states: Normal, alert, emergency, in extremis and restorative. State transition diagram showing various state transitions and control strategies.

Total: 45 Hours

Reference(s)

1. Olle. I. Elgerd, "Electric Energy Systems Theory", Tata McGraw Hill Publishing Company Ltd,New Delhi, Second Edition, 2017.
2. Allen.J.Wood and Bruce F.Wollenberg, "Power Generation, Operation and Control", John Wiley & Sons Inc., New York 2013.
3. P.Kundur, Om P. Malik, "Power System Stability and Control", Tata McGraw Hill Book Company, New Delhi,2022.
4. I.J. Nagarath, D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Company, New Delhi, 2022.
5. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, "Electrical Power Systems Analysis, Security and Deregulation", PHI Learning Private Limited, New Delhi, 2017

22EE002 POWER QUALITY 3 0 0 3

Course Objectives

- To analysis the various power quality phenomenon, their origin and effects.
- To summarize the causes and impacts of various power quality issues.
- To understand the methods of power quality monitoring and standards.
- To analysis the performance of passive compensators for mitigating the power quality issues.
- To design the active compensators for load compensation.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyze the different types of power quality problems like sag, swell, under voltage, overvoltage, inter harmonics so on with their source of generation.
2. Analyze the various causes and impacts of power quality issues due to commercial, domestic and industrial loads.
3. Apply different methodologies for monitoring, detection and classification of power quality problems.
4. Analyze the behavioral performance of passive shunt and series filters for mitigating the power quality issues generated in power systems.
5. Analyze FACTS controllers like distribution static compensator, dynamic voltage regulator and etc., for enhancing the quality of power.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO POWER QUALITY

Electric power quality phenomena. Classifications, characteristics and causes of short duration variation like sag, swell and interruption - Long duration variation like under voltage, over voltage and sustained interruption – Transients, voltage imbalance, power frequency variations and waveform distortion like harmonics and DC offset.

UNIT II **9 Hours**

CAUSES AND IMPACTS OF POWER QUALITY ISSUES

Voltage sag due to faults, induction motor starting and transformer energizing. Over voltages due to capacitor switching, lightning and Ferro resonance. Harmonic sources from commercial and industrial loads. Classification and analysis of nonlinear loads. Effects of various power quality issues.

UNIT III **9 Hours**

POWER QUALITY MONITORING AND STANDARDS

Monitoring considerations. Power Quality Measurement - wiring and grounding test devices, disturbance analyzers, Harmonic / spectrum analyzers and flicker meters. Smart power quality monitors, Expert system for power quality monitoring - IEEE and IEC standards.

UNIT IV **9 Hours**

PASSIVE COMPENSATION

Passive power filters - classifications, operations, design, modelling and performance analysis of passive shunt and series filters.

UNIT V **9 Hours**

ACTIVE COMPENSATION

FACTS devices: Classifications, operation, control methods, design and performance analysis of DSTATCOMs, DVRs and UPQCs.

Total: 45 Hours

Reference(s)

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, Electrical Power Systems Quality, McGraw Hill, 2017.
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons, 2015
3. Heydt, G.T., Electric Power Quality, Stars in a Circle Publications, Indiana, 2nd edition 1996.
4. Arrillaga, J, Watson, N.R., Chen, S., Power System Quality Assessment, Wiley, New York, 2011.
5. M.H.J Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions, New York, IEEE Press, 2011

22EE003 HIGH VOLATGE TRANSMISSION 3 0 0 3

Course Objectives

- To understand the concept of HVAC and HVDC transmission systems
- To understand the concept of conductor and insulator design
- To explore the methods to convert high-voltage AC to high-voltage DC
- To predict the fault and provide proper protection to HVAC & HVDC transmission systems
- To classify the various filters used to mitigate the harmonics

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyze the performance of HVAC system components.
2. Analyze the power transfer capabilities and power flow control in HVAC.
3. Analyze the characteristics of high voltage power converters in HVDC.
4. Apply suitable methods to measure and predict the faults in HVDC.
5. Analyze the harmonics mitigation technique using filters.

Articulation Matrix

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

UNIT I

HVAC CABLE DESIGN **9 Hours**

Design aspects of HVAC – conductor, tower, insulator and substation structure, design of EHVAC lines bas steady state limits and transient over voltages - design of extra HV cables - XLPE cables and gas insulated cable.

UNIT II

HVAC POWER FLOW CONTROL **9 Hours**

Real and reactive power flows in HVAC systems – reactive power compensation, short circuit level & real power transfer capacity - Stability- voltage stability and control - Theory of travelling and stationary waves.

UNIT III **9 Hours**

HVDC TRANSMISSION SYSTEM

Introduction to HVDC transmission - Bridge converters/rectifier and inverter operation/equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

UNIT IV **9 Hours**

HVDC PROTECTION AND CONTROL

Basic HVDC controllers, converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over-voltage protection.

9 Hours

UNIT V

HARMONICS MITIGATION AND HYBRID HVDC

Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters - Introduction to Hybrid HVDC - Design aspects of Hybrid HVDC system.

Total: 45 Hours

Reference(s)

1. S.Rao, "EHV-AC, HVDC Transmission and Distribution Engineering", Khanna Publishers, 3rd Edition, 2018.
2. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age International Publishers, 3rd Edition, 2019.
3. Padiyar K.R., "HVDC Transmission Systems", New Age International Publishers, 2nd Revised Edition, 2018.
4. C.L. Wadhwa, "High Voltage Engineering", Wiley Eastern Limited, 2019.
5. E.Kuffel and M. Abdullah, "High Voltage Engineering", Pergamon Press, 2019.
6. Alston, "High Voltage Technology" BS Publications, 2017.

22EE004 DEMAND SIDE MANAGEMENT 3 0 0 3

Course Objectives

- To understand the energy scenario.
- To understand fundamentals of smart grid.
- To understand the concept of demand side management.
- To understand the economics of demand side management programs.
- To apply the cost effectiveness of demand side management.

Programme Outcomes (POs)

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

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyse the Energy Conservation Schemes through interpretation of energy audit results
2. Apply the concept of current and voltage flow to perform distribution load flow analysis.
3. Apply the concept of load forecasting to monitor the energy scenario.
4. Analyze the distribution system by performing demand side management
5. Analyze the economics effectiveness of demand side management.

Articulation Matrix

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

UNIT I **9 Hours**

ENERGY SCENARIO

Energy Audit- Concept, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes; Measurements in Energy Audits, Presentation of Energy Audit Results

UNIT II **9 Hours**

LOAD FLOW ANALYSIS

Radial Distribution Network - Distribution load flow – Load flow analysis of balanced radial distribution system - Load flow analysis of unbalanced radial distribution system - Load flow analysis of balanced weakly meshed distribution system

UNIT III **9 Hours**

LOAD FORECASTING

Power Loads, Connected Load - Load Forecasting; Regression Analysis, Correlation Theory - Factors in Power System Loading - Unloading the System - Forecast of System Peak, Strategic Forecasting, Spatial Load Forecasting - Scenario Planning - Sources of Error: Regulating the Model.

UNIT IV **9 Hours**

DEMAND SIDE MANAGEMENT

Demand Side Management – Concept, Techniques, Benefits; Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning; Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs

UNIT V **9 Hours**

ECONOMICS OF DSM

The time value of Money Concept, Cash flow model, Pay back analysis, Depreciation, Net present value calculations; Taxes and Tax Credit –Numerical Problems; Importance of evaluation, measurement and verification of demand side management programs

Total: 45 Hours

Reference(s)

1. A S. Pabla, Electric Power Distribution, Tata McGraw-Hill Education, 2019.
2. B. Das, Power Distribution Automation, IET Power and Energy Series, 75, London, 2016.
3. Albert Thumann, ‘Fundamentals of Energy Engineering’, CRC Press, 2015
4. W.R. Murphy & G. Mckay Butter worth, Energy management, Heinemann publications, 2003.
5. Ashok V. Desai, Energy Demand – Analysis, Management and Conservation, Wiley Eastern, 2005.

22EE005 SMART GRID TECHNOLOGIES 3 0 0 3

Course Objectives

- To summarize the components used in smart grid and technologies involved in smart grid.
- To understand the concept of smart metering and implementation of demand side integration.
- To analyze the concepts in automated distribution systems in smart grid.
- To analyze the concepts in automated transmission systems in smart grid.
- To analyze the significance of power electronics in smart grid.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyze the operating principles and models of Smart Grid components.
2. Analyze the protocols of smart metering used in demand Side Integration.
3. Analyze the distribution system automation in Smart Grid.
4. Analyze the transmission system automation in Smart Grid.
5. Analyze the power quality improvement concepts in Smart Grid.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Electrical Grid - Definition of Smart Grid - Opportunities, Challenges and Benefits of Smart Grid - Inventory of Smart Grid Technologies - Operating Principles and Models of Smart Grid Components, Implementation of Smart Grid- Early Smart Grid initiatives - Overview of the technologies required for the Smart Grid.

UNIT II **9 Hours**

SMART METERING AND DEMAND-SIDE INTEGRATION

Introduction - Smart metering - Smart meters- An overview of the hardware used-Communications infrastructure and protocols for smart metering, Demand-side integration- Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations, Flexibility delivered by prosumers from the demand side, System support from DSI.

UNIT III **9 Hours**

DISTRIBUTION AUTOMATION

Distribution automation, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), High Efficiency Distribution Transformers, Phase Shifting Transformers.

UNIT IV **9 Hours**

TRANSMISSION SYSTEM AUTOMATION

Substation automation, Feeder Automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area monitoring systems (WAMS).

UNIT V **9 Hours**

COMPUTING TECHNOLOGIES FOR SMART GRID APPLICATIONS

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

Total: 45 Hours

References:

1. Bimal K Bose, "Power electronics in renewable energy systems and smart grid: technology and applications", IEEE Press, 2019.
2. B. Vinoth Kumar, P. Sivakumar, M.M. Rajan Singaravel, K. Vijayakumar, "Intelligent Paradigms for Smart Grid and Renewable Energy Systems",Springer, 2021.
3. Omar Ellabban, Shady S Refaat, Sertac Bayhan, Haitham Abu-Rub, Frede Blaabjerg, Miroslav Begovic, " Smart Grid and Enabling Technologies",Wiley - IEEE, 2021.
4. M. Kathiresh , A. Mahaboob Subahani , G. R. Kanagachidambaresan , "Integration of Renewable Energy Sources with Smart Grid", Wiley-Scrivener, 2021.
5. Ali Keyhani, " Design of smart power grid renewable energy systems", Wiley,2020.

22EE006 POWER SYSTEM DEREGULATION 3 0 0 3

Course Objectives

- To understand the need for restructuring of Power Systems, different market models and market power.
- To understand the market model, operations and challenges faced in a deregulation environment.
- To understand the transmission open access and congestion management methods.
- To apply the concepts and terminologies in pricing methodology and available transfer capability.
- To understand the reforms in the Indian Power Sector and for future expansion.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the restructuring process, new entities in power market and benefits.
2. Analyze the challenges faced in a deregulation environment with their market model and operations.
3. Analyze the transmission open access and congestion management methods.
4. Compute the pricing of power transactions and available transfer capability in a deregulation environment.
5. Analyze the reforms in Indian Power Sector and in future.

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

UNIT I **9 Hours**

POWER SYSTEM DEREGULATION: AN OVERVIEW

Introduction- Motivation for Restructuring of Power System- Electricity Market Entities and Model- Milestones of Deregulation-International Scenario - Benefits of deregulation- Basic Terminologies.

UNIT II **9 Hours**

COMPETITIVE WHOLESALE ELECTRICITY MARKET

Introduction - Restructuring models - Role of Independent system operator - Power exchange (PX) – Market Clearing Price (MCP) - Market operations - Whole sale electricity market characteristics - Challenges in wholesale electricity market.

UNIT III **9 Hours**

TRANSMISSION OPEN ACCESS

Introduction - Transmission open access- Types of Transmission services in open access - FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Congestion management - congestion management methods: An overview: Rescheduling of generation-Power World Simulation model.

UNIT IV **10 Hours**

PRICING AND AVAILABLE TRANSFER CAPABILITY

Introduction - Transmission cost components - Transmission pricing methods - Postage stamp method - contract path method-MW Mile method - Marginal participation method - Available Transfer Characteristics (ATC): Introduction -Definition - Methods of Static ATC Determination - Method based on multiple load flow and continuation power flow - method based on linear sensitivity factors - Power World Simulation model.

UNIT V **8 Hours**

INTERNATIONAL AND INDIAN POWER MARKET

Introduction - California Markets - New York Markets - PJM interconnection - Indian power sector past and present status-growth of power sector in India - overview - Time line of Indian power sector- Players in the Indian power sector.

Total: 45 Hours

Reference(s)

1. M.Shahidepour, Hatim Tamin and Zuyi Li, "Market operations in electric power system forecasting scheduling and risk management", John Wiley sons, 2002.
2. M.Shahidepour and M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", Marcel Dekker, Inc., 2001.
3. P.Venkatesh, B.V.Manikandan, S.Charles Raja and A.Srinivasan, "Electrical power systems analysis, Security and Deregulation", PHI 2012.
4. Loi Lei Lai, "Power system Restructuring and Deregulation" John Wiley sons, 2001.
5. Kankar Bhattacharya Maath H.J. Bollen and Jaap E.Daalder, "Operation of restructured power systems", Kluwer academic publishers, USA, first edition, 2001.

22EE045 FLEXIBLE AC TRANSMISSION SYSTEMS 3 0 0 3

Course Objectives

- To understand the needs and working of FACTS devices.
- To understand the working and operation compensation devices.
- To understand the concept of Static Voltage and Phase Angle Regulator.
- To understand the concept of Emerging FACTS controllers.

Programme Outcomes (POs)

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Understand the necessity and benefits of FACTS controllers.
2. Analyze the shunt compensation devices used for power factor improvement.
3. Compare series compensation devices based on their operating characteristics.
4. Examine the operation of thyristor controlled voltage and phase angle regulators.
5. Analyze the operation of emerging FACTS controllers.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO FACTS

Electrical Transmission Network - opportunities for FACTS - Power Flow in AC System – relative importance of controllable parameter.

UNIT II **10 Hours**

SHUNT COMPENSATION

Need for compensation - introduction to shunt compensation - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) - Comparison of TCR & TSC.

UNIT III **9 Hours**
SERIES COMPENSATION

Introduction to series compensation - Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series Capacitor (TCSC) - Comparison of TSSC & TCSC.

UNIT IV **8 Hours**
STATIC VOLTAGE PHASE ANGLE REGULATOR

Objectives of voltage & phase angle regulators - approaches to Thyristor - Controlled Voltage & Phase Angle Regulator.

UNIT V **8 Hours**
EMERGING FACTS CONTROLLER
STATCOM - Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC) - Introduction to sub synchronous resonance.

Total: 45 Hours

Reference(s)

1. R. Mohan Mathur and Rajiv K.Varma, Thyristor Based FACTS Controller for Electrical Transmission Systems, Wiley Interscience Publications, 2016.
2. Narain G. Hingorani & Laszlo Gyugyi, Understanding FACTS - Concepts & Technology of Flexible AC Transmission Systems, Standard Publishers, New Delhi, 2015.
3. T. J. E. Miller, Reactive Power Control in Electric System, John Wiley & Sons, 2014.
4. Narain G. Hingorani, Flexible AC Transmission, IEEE Spectrum, April 1993, pp 40-45
5. Elinar V. Larsen, Juan J Sanchez - Gasca Joe H. Chow, Concepts for design of FACTS controllers to damp power swings, IEEE Transactions on Power Systems, Vol. 10, No. 2, May, 1995.

VERTICAL II POWER ELECTRONICS AND DRIVES

22EE007 ADVANCED POWER SEMICONDUCTOR DEVICES 3 0 0 3

Course Objectives

- To learn the characteristics of different types of semiconductor devices.
- To analyze the characteristics of power transistor
- To understand the construction and working principle of Thyristor
- To understand the operation and analyze the characteristics of power controlled devices
- To explore the need for isolation circuits and protection circuits

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the performance characteristics of ideal and practical power switches
2. Assess the performance characteristics of power transistor
3. Analyze the static and dynamic characteristics of thyristor
4. Analyze the static and switching characteristics of power controlled devices
5. Design a snubber and driver circuits for power controlled devices

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Power switching devices -Attributes of an ideal switch, application requirements- circuit symbols - Power handling capability (SOA); Device selection strategy - On-state and switching losses - EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics - Rating.Introduction to wide band gap semiconductors such as silicon carbide and gallium nitride.

UNIT II **9 Hours**

POWER TRANSISTOR

BJTs - Construction, static characteristics, switching characteristics - Negative temperature coefficient and Secondary breakdown - Power Darlington - Thermal protection-dynamic models of BJT

UNIT III **9 Hours**

THYRISTOR

Thyristors - working principle and its operating modes- Two transistor analogy- concept of latching - Gate and switching characteristics - Converter grade and inverter grade and other types; series and parallel Operation -Comparison of BJT and Thyristor- Steady state and dynamic models of BJT and Thyristor - thermal protection

UNIT IV **9 Hours**

POWER CONTROLLED DEVICES

Principle, construction, types of Power MOSFETs and IGBTs- static and switching characteristics -Steady state and dynamic models of MOSFET and IGBTs; Basics of GTO, MCT, and IGCT

UNIT V **9 Hours**

FIRING AND PROTECTING CIRCUITS

Necessity of isolation circuit- Pulse transformer- Opto-coupler; Gate drive circuit for SCR,MOSFET, IGBTs and base driving for power BJT - Overvoltage, over current and gate protections, Design of snubbers.

Total: 45 Hours

Reference(s)

1. Timothy L. Skvarenina, “The power electronics handbook”, CRC press, New Delhi, 2012.
2. M. H. Rashid, “Power Electronics circuits, Devices and Applications”, Prentice Hall of India, New Delhi, 2011.
3. Shen, Shyh-Chiang, “Wide-bandgap device research and development at SRL”, Georgia Instituteof Technology Semiconductor Research Laboratory, retrieved 2014-09-03.
4. Baliga, B. Jayant, “Fundamentals of Power Semiconductor Devices”, springer, 2008.
5. Ned Mohan, Undeland and Robins, “ Power Electronics Concepts, applications and design”, John Wiley and sons, Singapore, 2000.
6. D. Singh and K. B. Khanchandani, “Power Electronics”, Tata McGraw Hill book Co,New Delhi, 2003.

22EE008 ADVANCED POWER CONVERTERS

Course Objectives **3 0 0 3**

- To analyze the closed loop operation of switched mode power supplies.
- To understand the operation of switched mode rectifiers.
- To understand and analyze the various types of multilevel inverters.
- To evaluate the operation, and performance parameters of matrix converters.
- To understand the operation of soft switched power converters.

Programme Outcomes (POs)

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

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

PO3.Design/Development of Solutions: Design solutions for complex engineering problems and designsystem components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the various converter topologies to design and analyze the switched mode power supplies.
2. Evaluate the input and output parameters of controlled rectifiers with PWM techniques.
3. Analyze the operation of advanced multilevel inverters with different modulation schemes.
4. Analyze the performance parameters of AC- AC converters with and without DC link.
5. Apply the soft switching techniques and analyze the performance of hard switched and soft switched converters.

Articulation Matrix

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

UNIT I **9 Hours**

SWITCHED MODE POWER SUPPLIES (SMPS)

DC Power supplies and Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs- Closed loop control and regulation- Design examples on converter and closed loop performance.

UNIT II **9 Hours**

AC-DC CONVERTERS

Switched mode AC-DC converters-synchronous rectification - single and three phase topologies - switching techniques - Power Factor: power factor improvement techniques- reduced input current harmonic distortion - with and without input-output isolation.

UNIT III **9 Hours**

DC-AC CONVERTERS

Multi-level Inverter-operation with equal and unequal DC voltages, - Inverters for open ended load configurations - Carrier modulation schemes of multilevel inverter, SVPWM of Multilevel inverter, Neutral Point Balancing schemes.

UNIT IV **9 Hours**

AC-AC CONVERTERS WITH AND WITHOUT DC LINK

Matrix Converters-Modulation techniques - scalar modulation, indirect modulation-Matrix converter as only AC- DC converter-AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter.

UNIT V **9 Hours**

SOFT-SWITCHING POWER CONVERTERS

Soft switching techniques-ZVS, ZCS, quasi resonance operation-Performance comparison hard switched and soft switched converters-AC-DC converter, DC-DC converter, DC-AC converter- Resonant DC power supplies.

Total: 45 Hours

Reference(s)

1. Muhammad H.Rashid, "Power Electronics Circuits, Devices & Applications", 4th Edition, Pearson India, 2018.
2. Ned Mohan, Tore. M. Undeland, William. P. Robbins, "Power Electronics: Converters, Applications and Design", 3rd Edition Wiley India, NewDelhi, 2012.
3. M.D.Singh & K.B Khanchandani, "Power Electronics", 2nd Edition, Tata Mc Graw Hill Publishing Co.Ltd., New Delhi, 2017.
4. Robert W.Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Soringer Nature Switzerland AG 2020.
5. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, "Control in Power Electronics- Selected Problem",Academic Press (Elsevier Science), 2002.
6. José Rodríguez, , Jih-Sheng Lai, and Fang Zheng Peng, "Multilevel Inverters: A Survey of Topologies, Controls, and Applications", IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2002.

22EE009 MODERN RECTIFIERS AND RESONANT CONVERTERS

3 0 0 3

Course Objectives

- To understand the importance of harmonics standards and operation of rectifiers in CCM & DCM.
- To analyze and design power factor correction rectifiers for UPS applications.
- To understand the source current shaping methods for rectifiers.
- To understand the resonant converters for SMPS applications.
- To analyze the performance of DC- DC Converters.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the types of modern rectifiers and select a rectifier for real time applications.
2. Analyze the performance of PWM inverters for specific applications.
3. Analyze the characteristics of resonant converters for different loads.
4. Apply the working linear system, state space model, PI controller.
5. Design a DC power supplies using advanced controller logic.

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

UNIT I **9 Hours**

LINE COMMUTATED RECTIFIERS

AC line current harmonic standards IEC1000-IEEE 519-CCM and DCM operation of single phase full wave rectifier- Behaviour of full wave rectifier for large and small values of capacitance - CCM and DCM operation of three phase full wave rectifier- 12 pulse converters- Multi Pulse converters - Harmonic trap filters

UNIT II **9 Hours**

PULSE WIDTH MODULATED RECTIFIERS

Properties of Ideal single phase rectifiers-Realization of nearly ideal rectifier-. Single-phase converter systems incorporating ideal rectifiers - Losses and efficiency in CCM high quality rectifiers -Single-phase PWM rectifier - device selection for rectifiers - Three phase PWM rectifier - applications of rectifiers

UNIT III **9 Hours**

DYNAMIC ANALYSIS OF SWITCHING CONVERTERS

Review of linear system analysis-State Space Averaging-Basic State Space Average Model State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter and an ideal Cuk Converter. Pulse Width modulation - Voltage Mode PWM Scheme - Current Mode PWM Scheme - Design of PI controller.

UNIT IV **9 Hours**

RESONANT CONVERTERS

Soft Switching - classification of resonant converters - Quasi resonant converters- multi resonant converters - operation and analysis of ZVS and ZCS multi resonant converter - zero voltage transition PWM converters - zero current transition PWM converters

UNIT V **9 Hours**

SOURCE CURRENT SHAPING OF RECTIFIERS

Need for current shaping - power factor - functions of current shaper - input current shaping methods - passive shaping methods -input inductor filter - resonant input filter - active methods - boost rectifier employing peak current control - average current control - Hysteresis control Nonlinear carrier control.

Total: 45 Hours

Reference(s)

1. Robert W Erickson and Dragon Maksimovic Fundamentals of Power Electronics Second Edition Springer science and Business media 2001.
2. William Shepherd and Li Zhang Power Converters Circuits Marceld Ekkerin C 2005.
3. Simon Ang and Alejandro Oliva Power Switching Converters Taylor and Francis Group 2010.
4. Andrzej M. Trzynadlowski Introduction To Modern Power Electronics John Wiley and Sons 2016.
5. Marian.K.Kazimierczuk and Dariusz Czarkowski Resonant Power Converters John Wiley and Sons limited 2011.
6. D. Grahame Holmes Thomas A. Lipo Pulse Width Modulation for Power Converters Principles and Practice Wiley IEEE Press 2003

22EE010 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

Course Objectives

- Acquire knowledge on electromagnetic interference and electromagnetic compatibility.
- To understand the EMI and EMC standards
- To understand the EMI in electric circuits.
- To interpret the Noise suppression techniques.
- To select the appropriate EMI filtering methods.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyse the types and sources of EMI.
2. Apply the suitable measurement techniques and standards for EMI problems
3. Evaluate the EMI in electrical circuits
4. Apply appropriate techniques to control EMI.
5. Design a filter to suppress the EMI.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Sources of EMI- Inter systems and Intra systems EMI- Conducted and radiated interference-Characteristics -EMI predictions and modeling, - Methods of eliminating interferences- Design of electromagnetic compatibility (EMC) - EMC regulation typical noise path.

UNIT II **9 Hours**

EMI MEASUREMENT AND STANDARDS

EMI Measuring Instruments, Test Equipment, Measurement of Interference Voltage and Current-Spectrum Analysers - EMI Measurements for Consumer Appliances, Standards: Basic Standards, Product Standards, IEC, ANSI, FCC,CISPR, BSI,CENELEC, ACEC and MIL61E standards.

UNIT III **9 Hours**

EMI IN ELEMENTS AND CIRCUITS

Electromagnetic emissions, noise from relays and switches, non-linearity in circuits, passive intermodulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction

UNIT IV **9 Hours**

NOISE SUPPRESSION TECHNIQUES

Noise Suppression in Relay Systems, Application of ACS switching Relays, Application of RC – Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at Its Source, Influence of Layout and Control of Parasitic.

UNIT V **9 Hours**

EMI FILTER CIRCUITS

Selection and Measurement, Test Methods, EMI Filter Design,-Insertion Loss, Design Method for Mismatched Impedance Condition, Design of EMI Filters with Common- Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements.

Total: 45 Hours

Reference(s)

1. L. Tihanyi, "Electromagnetic compatibility in Power Electronics", IEEE press, 2020.
2. Bruce Archambeault, Colin Brench, Omar M. Ramahi, "EMI/EMC computational modelling handbook", Kluwer press, second edition, 2018.
3. D. Morgan, "A Handbook for EMC Testing and Measurement", IET Electrical Measurement Series, Band 8, 2018
4. Tim Williams, "EMC for product designers", Newnes press, fifth edition, 2016.
5. Henry W.Ott, “Noise reduction techniques in electronic systems”, John Wiley & Sons, 1989.
6. José Rodríguez, , Jih-Sheng Lai, and Fang Zheng Peng, ‘Multilevel Inverters: A Survey of Topologies, Controls, and Applications’, IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2015.

22EE011 ELECTRIC DRIVES AND CONTROL 3 0 0 3

Course Objectives

- To understand the motor, load dynamics, their nature and classification.
- To apply power electronic converters to control the speed of DC motors.
- To analyze the speed control techniques for induction motor drives
- To analyze the performance of synchronous motor drives.
- To select the special electrical machines and control schemes for various industrial applications

Programme Outcomes (POs)

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field ofElectrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the dynamics of electrical drives, their nature and classification
2. Analyze the chopper fed DC drive.
3. Analyze the speed control techniques of induction motor drives
4. Analyze the performance of synchronous motor drives.
5. Select the special electrical machines and apply control schemes for various industrial applications

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Concepts, and classification of Electric drives. Selection of motors. Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics steady state stability and transient stability. Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.

UNIT II **9 Hours**

DC MOTOR DRIVE

Basic characteristics, Operating modes, Single phase and three phase controlled rectifier fed DC drives, Dual converters drives, Chopper drives, Rheostatic and regenerative braking, effects of changes in supply voltage and load torque, closed loop control schemes.

UNIT III **9 Hours**

INDUCTION MOTOR DRIVES

Induction motor drives, stator voltage control, stator impedance control, rotor voltage control – Slip power recovery schemes, V/f control, Current control method. Need for harmonic filter, Closed loop control. Introduction to vector control scheme.

UNIT IV **9 Hours**

SYNCHRONOUS MOTOR DRIVES

Speed torque characteristics and torque angle characteristics. Fixed and variable frequency operation modes, Self-control modes.

UNIT V **9 Hours**

SPECIAL MACHINES

Brushless DC motor, Switched Reluctance Motor, introduction to the relevant converter circuits.

Total: 45 Hours

Reference(s)

1. G. K. Dubey, et.al., "Thyristorised Power Controllers," New Age International, 2002.
2. Vedam Subramanyan, Electric Drives: Concepts and Applications, Tata McGraw Hill Publishing Company, New Delhi, 2011.
3. Krishan. R,'Permanent Magnet Synchronous and Brushless DC Motor Drives', CRC Press, 2010
4. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051, McGraw Hill Education, 2013.
5. P. S. Bimbra Power Electronics, Khanna Publishers, third Edition, 2003.

22EE012 POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SOURCES 3 0 0 3

Course Objectives

- To analyse the current scenario of the implementation of renewable energy system.
- To understand the modern power converters for solar thermal systems.
- To understand the interfacing of power converters with wind energy systems
- To understand the operations of various generators used in WECS.
- To analyse the distributed power generation systems.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO12.Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the rules and regulations for development of new energy technologies
2. Analyze the power converters for standalone solar power conversion system
3. Analyze the different configurations of wind energy conversion system
4. Analyze the converters for grid connected WECS and SECS
5. Apply the concepts of solar PV and wind energy conversion system to develop the distributed power generation system.

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

UNIT **9 Hours**
INTRODUCTION

Trends in energy consumption - World energy scenario - Energy sources and their availability - Conventional and renewable energy resources - Need to develop new energy technologies - Current status of renewable energy sources - Government Bodies and its function - MNRE & TEDA.

UNIT II **9 Hours**

SOLAR PV SYSTEMS

Solar radiation and measurements - Solar cells - Panels and their characteristics -Influence of insolation, temperature and parasitic capacitance PV arrays - power Converters-Maximum power point tracking - Applications.

UNIT III **9 Hours**

WIND ENERGY SYSTEMS

Principle of Wind Energy Conversion System- Nature of Wind - Components of Wind Energy Conversion System- Modern generators for WECS - Power conditioning schemes.

UNIT IV **9 Hours**

GRID CONNECTED WECS AND SECS

Grid codes- grid connectors -Grid related problems and standards-conventional and new grid synchronisation Methods-Generator control - Power converters for Grid connected WECS - Power converters for Grid connected SECS.

UNIT V **9 Hours**

DISTRIBUTED POWER GENERATION SYSTEMS

Hybrid Systems - Selection of power conversion ratio -Optimization of System components - Micro Hydro, wind, solar, and fuel cell systems - Converters and controllers for integration of renewable energy sources- types of energy storage systems

Total: 45 Hours

Reference(s)

1. S. Rao and Parulekar, Energy Technology Non Conventional, Renewable and Conventional, New Delhi, Khanna Publishers, 1999.
2. Rai G.D, Non conventional energy sources, Khanna Publishers, 1993.
3. Mukund R. Patel, Wind and Solar Power System, New York, CRC Press LLC, 1999.
4. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2003.
5. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.

VERTICAL III - ELECTRIC VEHICLE TECHNOLOGY

22EE013/22EEH13/22EEM13 ELECTRIC VEHICLE ARCHITECTURE

3 0 0 3

Course Objectives

- To u nderstan d the sizing and architecture of Electric vehicles.
- To apply the propulsion mechanics for Electric Vehicles.
- To analyse the power components and braking system for Electric Vehicles.
- To apply the various control strategies for Electric Vehicles.
- To apply the concepts of Plug-in Hybrid Electric Vehicle.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Assess the sizing of various components of Electric Vehicle.
2. Design a propulsion system for Electric Vehicle.
3. Analyse the power components and braking system for Electric Vehicles.
4. Apply the various control strategies for Electric Vehicles.
5. Apply the concept of plug-in hybrid electric vehicle.

Articulation Matrix

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

UNIT I
VEHICLE ARCHITECTURE AND SIZING **9 Hours**
Electric Vehicle – History and Evolution, Series, Parallel and Series Parallel Architecture, Micro and Mild architectures - Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT II **9 Hours**
VEHICLE MECHANICS
Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III **9 Hours**
POWER COMPONENTS AND BRAKES
Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

UNIT IV **9 Hours**
HYBRID VEHICLE CONTROL STRATEGY
Classification of control strategies: series, parallel, and power split-Different operating modes of hybrid vehicles: electric-only, engine-only, hybrid, regenerative braking-Control strategies for optimizing energy management and efficiency.

UNIT V **9 Hours**
PLUG-IN HYBRID ELECTRIC VEHICLE
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

Total: 45 Hours

Reference(s)

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020

22EE014/22EEH14/22EEM14 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

3 0 0 3

Course Objectives

- To familiarize with power electronic components configuration to review the drive cycles and requirements of EVs
- To expose the utilization of different motors used in Electric Vehicle
- To learn the methods for analysing the behaviour of nonlinear control systems.
- To inculcate the knowledge to design and analyse power converters suitable for EV
- To design and analyse the transfer function of DC-DC converter used in EV

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complexengineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Assess the various parameters in dynamics of electric vehicles.
2. Apply controls of different motors for drive system efficiency.
3. Apply linear quadratic optimal controllers for scalar systems, and evaluate design parameters influence the closed-loop system properties.
4. Design and analyse closed loop Power converters for EV.
5. Analyse power electronics circuits and losses occurring in practice.

Articulation Matrix

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

UNIT I **9 Hours**

ELECTRIC VEHICLE DYNAMICS

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

UNIT II **9 Hours**

MOTORS FOR ELECTRIC VEHICLES

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT III **9 Hours**

BASICS OF SIMULATION IN CONTROL SYSTEMS

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model

UNIT IV **9 Hours**

MODELING OF DC-DC CONVERTERS

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

UNIT V **9 Hours**

POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

Total: 45 Hours

Reference(s)

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications
3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.
6. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.

22EE015/22EEH15/22EEM15 ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL

3 0 0 3

Course Objectives

- To understand the basics of EV and vehicle mechanics
- To identify the EV architecture and its types
- To find out the various types of energy storage system concepts
- To derive model for batteries and to know the different types of batteries and its charging methods
- To comprehend the control preliminaries for DC-DC converters.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7.Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyse the internal combustion engine based on vehicle fuel economy, emission control systems
2. Assess the vehicle mechanics of EV and HEV
3. Analyse the battery pack and battery charging methods for different types of battery
4. Analyze the stability of boost converter using bode plot
5. Assess the performance of AC motor with vector control and direct torque control.

Articulation Matrix

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

UNIT I **9 Hours**
INTERNAL COMBUSTION ENGINES
IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT II **9 Hours**
ELECTRIC VEHICLES AND VEHICLE MECHANICS
Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT III **9 Hours**
BATTERY MODELING, TYPES AND CHARGING
Batteries in Electric & Hybrid Vehicles – Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium & Nickel-Metal-Hydride (NiMH) Battery - Li-Ion & Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur & Sodium-Metal-Chloride, R&D for Advanced Batteries. Battery- Modelling, Pack Management & Charging, Electric Circuit Models.

UNIT IV **9 Hours**
CONTROL PRELIMINARIES
Control Design Preliminaries - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

UNIT V **9 Hours**
CONTROL OF AC MACHINES
Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

Total: 45 Hours

Reference(s)

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
3. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
5. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017, 2nd Edition.
6. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997, 1st Edition.

22EE016/22EEH16/22EEM16 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM

3 0 0 3

Course Objectives

- To understand the fundamental concept of charging stations and their standards.
- To learn about the working of power converters in electric vehicle charging stations.
- To find the various electric vehicle charging schemes using renewable energies and storage systems.
- To demonstrate the wireless power transfer technique for electric vehicle charging systems.
- To understand the necessity of PF improvement and design power factor correction circuits.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the modes and principle of various charging techniques, charging standards and regulations.
2. Analyze the working of DC-DC converters used in the EV charging systems.
3. Assess the performance of renewable energy-based charging systems.
4. Analyze the working principle of wireless power transfer in EV charging systems.
5. Evaluate the performance of power converters by boosting the power factor.

Articulation Matrix

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

UNIT I **9 Hours**
CHARGING STATIONS AND STANDARDS
Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

UNIT II **9 Hours**
POWER ELECTRONICS FOR EV CHARGING
Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit,with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC– DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III **9 Hours**
EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS
Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV **9 Hours**
WIRELESS POWER TRANSFER
Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

UNIT V **9 Hours**
POWER FACTOR CORRECTION IN CHARGING SYSTEM
Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

Reference(s)

Total: 45 Hours

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.
3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.
5. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
6. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

22EE017/22EEH17/22EEM17 GRID INTEGRATION OF ELECTRIC VEHICLES

3 0 0 3

Course Objectives

- To understand the Vehicle-to-Grid (V2G) technology in the context of electric vehicle integration with the power grid.
- To understand the grid stability, energy efficiency, and economic advantages of V2G
- To identify and examine the challenges and barriers faced in the successful implementation of V2G.
- To Understand the impact of Electric Vehicles (EVs) and V2G technology on the smart grid and renewable energy systems.
- To comprehend the principles and strategies for effectively integrating and managing Electric Vehicles (EVs) within the existing power grid infrastructure.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Assess V2G potential impact on the power grid and energy management.
2. Analyse the benefits of V2G integration, propose strategies for enhancing sustainable energy systems
3. Analyse the key challenges hindering V2G adoption, propose potential solutions for effective grid integration
4. Assess the influence of EVs and V2G on grid stability for optimizing their synergisticeffects.
5. Design and implement grid integration solutions of EVs while maintaining grid stability and efficiency.

Articulation Matrix

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

UNIT I **9 Hours**

DEFINITION, And STATUS Of V2G

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications . Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G

UNIT II **9 Hours**

BENEFITS OF V2G

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainabilityin Electricity and Transport, Other Benefits.

UNIT III **9 Hours**

CHALLENGES TO V2G

Battery Limitations and Vehicle Considerations- Policy and Regulatory Hurdles for V2G Adoption-Ensuring Data Security and Privacy in V2G- Overcoming User Resistance to V2G Participation-Planning for V2G Integration in the Power Grid- Assessing Environmental Impacts of V2G Deployment

UNIT IV **9 Hours**

IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS

EV Charging Infrastructure and Grid Integration - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

UNIT V **9 Hours**

GRID INTEGRATION AND MANAGEMENT OF EVS

Importance of Grid Integration - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

Total: 45 Hours

Reference(s)

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press 2017, 1st Edition.
2. Sumedha Rajakaruna , Farhad Shahnia and Arindam Ghosh , "Plug In Electric Vehicles in Smart Grids, Charging Strategies",Springer,2015, 1st Edition.
3. Nand Kishor , Jesus Fraile- Ardanuy, " ICT for Electric Vehicle Integration with the Smart Grid", IET 2020, 1st Edition.
4. Junwei Lu and Jahangir, "Hossain Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid",IET 2015, 1st Edition.
5. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, "Vehicle- to-Grid A SocIoTechnical Transition Beyond Electric Mobility", 2019, 1st Edition.

22EE018/22EEH18/22EEM18 INTELLIGENT CONTROL OF ELECTRIC VEHICLES

3 0 0 3

Course Objectives

- To understand the mathematical model of a BLDC motor and its characteristics
- To understand the different control schemes for BLDC motor
- To understand the need of fuzzy in control of electric vehicles
- To understand the fundamentals of FPGA and VHDL
- To understand the fuzzy logic control of BLDC motor .

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, andsynthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the mathematical model of a BLDC motor and to discuss about its characteristics.
2. Analyze the various speed control methods for controlling the speed of BLDC motor.
3. Analyze the concept of fuzzy system
4. Apply VHDL & FPGA to control EVs.
5. Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

Articulation Matrix

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

UNIT I **9 Hours**
MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR
Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Differential Equations, Transfer Functions, State-Space Equations., Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients, safety considerations.

UNIT II **9 Hours**
SPEED CONTROL FOR ELECTRIC DRIVES
Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

UNIT III **9 Hours**
FUZZY LOGIC
Membership functions, Fuzzification, Defuzzification, Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Rule Base and Approximate Reasoning, Fuzzy Propositions, Rule Formation and Decomposition, Aggregation, Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert System, Fuzzy Decision Making.

UNIT IV **9 Hours**
FPGA AND VHDL BASICS
Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type- conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNIT V **9 Hours**
REAL TIME IMPLEMENTATION
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

Total: 45 Hours

Reference(s)

1. John G. Hayes, G. Abas Goodarzi, ‘Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles’ Wiley 1st Edition 2018.
2. Jayaram Bhasker, ‘VHDL Primer’, A (3rd Edition), Prentice Hall, 1st Edition 2015.
3. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 2021, 1st Edition.
4. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
5. M.N. Cirstea, A. Dinu, J.G. Khor, M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
6. Wei Liu, ‘Hybrid Electric Vehicle System Modelling and Control’, Wiley 2017, 2nd Edition.

22EE041/22EEH41/22EEM41 IoT FOR INDUSTRY AUTOMATION **3 0 0 3**

Course Objectives

- Understand the IoT concept and its impact
- Recognize various communication and platforms for implementing IoT.
- Learn how to use Hardware to perform varying and complex tasks.
- Understand advanced and emerging technologies.
- Develop skills to design and develop applications in different aspects.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints**.**

Course Outcomes (COs)

1. Analyze the various technologies, architectures, standards, and regulation inIoT.
2. Analyze the types of communication protocols used in IoT platforms.
3. Analyze the various IoT technologies for the particular industrial application.
4. Evaluate and compare the data collected from various connected devices.
5. Analyze the role and implementation of microcontrollers in IoT.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Evolution of Internet of Things – Enabling Technologies – IoT Architectures, Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT Challenges and Issues.

UNIT II **9 Hours**

IoT ARCHITECTURE AND COMPONENTS:

IoT Architecture: Node, Gateway, Network infrastructure and Cloud server – Components of IoT:Control Unit, Communication modules Bluetooth Zigbee, Wifi ,GPS- IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication.

UNIT III **9 Hours**

HARDWARES AND TECHNOLOGIES

IoT Hardware Considerations – IoT programming Considerations – Open source hardware platforms, designing of Proprietary Hardware – Four pillars of IoT paradigm, RFID, M2M - IoT Enabling Technologies.

UNIT IV **9 Hours**

IoT CLOUD PLATFORMS:

IoT Cloud Services Front-end EDGE devices, Enterprise data for IoT, Emerging descriptive data standards for IoT, Cloud database, Cloud computing, Fog and Edge computing.

UNIT V **9 Hours**

PROGRAMMING THE MICROCONTROLLER

Working principles of sensors IoT deployment for Raspberry Pi /STM /Equivalent plat- form Reading from Sensors, Communication: Connecting microcontroller with mobile devices, communication through Bluetooth, wifi and USB Case Studies: Smart Farming: Weather monitoring, Smart Grid and Solar Energy Harvesting

Total: 45 Hours

Reference(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,”IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, First Edition, Cisco Press, 2017.
2. Andrew Minteer, Analytics for the Internet of Things (IoT)‘, Packet Publishing Limited, 2017.
3. Peter Waher, “Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3”, First Edition, Packt Publishing, 2018.
4. Peter Waher, 'Learning Internet of Things', Packet Publishing, 2015, 3rd Edition, OvidiuVermesan.
5. Buyya, Rajkumar, and Amir VahidDastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

22EE042/22EEH42/22EEM42 ROBOTICS AND AUTOMATION **3 0 0 3**

Course Objectives

- Understand the basic robotic terminologies and various parts of robots.
- Understand the types of power sources, sensors and actuators used for robotic machine interface.
- Understand the manipulator dynamics and gripper types.
- Analyze kinematics and path planning equations for standard configurations.
- Apply various control schemes to achieve control of single and multiple robots.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (Cos)

1. Apply the fundamental concepts of robotics including classifications, degrees of freedom, and dynamic stabilization in industrial applications.
2. Apply the appropriate sensor and actuator for the design of robot machine interface.
3. Analyse manipulator and gripper operation.
4. Analyse kinematic and path planning equations for standard configurations.
5. Apply various control schemes for Robotics control.

Articulation Matrix

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

UNIT I **9 Hours**

BASIC CONCEPTS

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Robot classifications and specifications- Asimov's laws of robotics – dynamic stabilization of robots.

UNIT II **9 Hours**

POWER SOURCES, SENSORS AND ACTUATORS

Hydraulic, pneumatic and electric drives: Design and control issues – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

UNIT III **9 Hours**

MANIPULATORS AND GRIPPERS DIFFERENTIAL MOTION

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

UNIT IV **9 Hours**

KINEMATICS AND PATH PLANNING

Linear and angular Velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance Solution kinematics problem – robot programming languages.

UNIT V **9 Hours**

DYNAMICS, CONTROL AND APPLICATIONS

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler Formulation-Dynamic model –Linear control schemes-PID control scheme. Multiple robots – machine interface – robots in manufacturing and non-manufacturing applications –robot cell design – selection of robot.

Total: 45 Hours

REFERENCES

1. Héctor A. Moreno, Ilka A. Banfield, Isela G. Advances in Automation and Robotics Research, Springer publisher,2021.
2. Thomas R. Kurfess, Robotics and Automation Handbook, CRC Press, 2018.
3. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore,2015.
4. Saeed B Niku, Introduction to Robotics, Analysis, Systems, Applications Prentice Hall, 3 edition 2014.
5. JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education,2009.

VERTICAL IV – GREEN ENERGY TECHNOLOGY

22EE019 SOLAR ENERGY CONVERSION SYSTEMS 3 0 0 3

Course Objectives

- To provide solar radiation and its measurement techniques
- To understand the overview of solar pv cell and its mathematical model.
- To attain a broad comprehension on solar photovoltaic standalone and grid connected system
- To understand the operations of solar thermal energy conversion system.
- To understand the applications of solar pv and solar thermal systems

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

Course Outcomes (COs)

1. Apply the various instruments for measuring solar radiation.
2. Analyse the I-V characteristics of Solar PV System and conversion efficiency
3. Design a converter control topology for standalone and grid connected PV systems.
4. Analyse the different types of solar thermal energy collectors.
5. Apply a suitable Solar PV or thermal systems for various domestic and industrial applications.

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

UNIT I **9 Hours**

SOLAR RADIATION AND MEASUREMENT

Electromagnetic spectrum-Solar angles-Sun path diagrams-Solar insolation- -Radiation absorption, scattering -Measurement of radiation-Pyranometer-Pyrheliometer-Sunshine recorder.

UNIT II **10 Hours**

SOLAR PV CELL

Formation of a PN – junction - Space charge and internal field - Quasi - Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - I-V characteristics - Fill factor - Crystalline silicon solar cells - Thin film solar cells - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Conditions for maximum power Transfer-Conversion efficiency- Basics of Load Estimation.

UNIT III **8 Hours**

STAND-ALONE AND GRID CONNECTED PV SYSTEMS

Grid interconnection standards- - Inverter control topologies for standalone and grid connected systems-Feasible operating region of inverter for grid connected system -Real time issues in grid connected systems- Maximum Power Point Tracking algorithms.

UNIT IV **9 Hours**

SOLAR THERMAL ENERGY CONVERSION

Solar thermal energy- Solar flat plate collector, solar evacuated tube collector, Disc Collectors -Pool and Air Collectors Construction -Function - Solar heating and cooling system - Real time issues in solar thermal systems- Comparison of solar thermal and Solar PV systems.

UNIT V **9 Hours**

APPLICATIONS OF SOLAR PV AND SOLAR THERMAL SYSTEMS

Solar PV power plant - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping -Solar thermal electric power plant -solar thermal applications: heating, cooling, desalination, drying, cooking, Solar Ponds.

Total: 45 Hours

Reference(s)

1. CS Solanki, Solar Photovotaics, Fundamentals, Technologies and Applications, 3rd edition, PHI Learning Pvt. Ltd., 2015.
2. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications PrenticeHall, 2008.
3. H.P. Garg and J. Prakash., Solar Energy,Fundamentals & Applications, Tata McGraw Hill book Co, New Delhi, 2017.
4. S.P. Sukhatme, J.K. Nayak, Solar Energy-Principle of thermal storage and collection, Tata McGraw Hill book Co, 3rd edition New Delhi, 2011.
5. G.N.Tiwari, Solar Energy-Fundamentals, Design,Modeling and Applications,Narosha Publishing House Ltd.,2013.
6. Amine Allouhi et al. Up-to-date literature review on Solar PV systems: Technology progress, market status and R&D, Journal of Cleaner Production (2022)

22EE020 WIND POWER TECHNOLOGY 3 0 0 3

Course Objectives

- To understand the wind power scenario, characteristics and classifications of WECS.
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To understand the operations of various generators used in WECS.
- To analyze the grid integration issues.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field ofElectrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the performance of wind energy conversion system and select a suitable site for wind power generating station.
2. Analyze the performance of different wind turbines and apply a control mechanism for maximum power extraction.
3. Analyze the performance different types of generator and select a generator for fixed speed wind turbine systems.
4. Apply the characteristics of generators used in variable speed, constant frequency wind energy conversion systems.
5. Analyze the interconnection requirements and safety measures for grid connected wind energy systems to improve the power quality.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Wind source -Characteristics of Wind Energy-Wind Energy Conversion System (WECS) siting - Classification- Types of Towers -Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Aerodynamics of Wind turbine- offshore Wind Turbine.

UNIT II **9 Hours**

WIND TURBINES

Terminologies-Types of Wind Power Plants-HAWT and VAWT -Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-Number of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III **9 Hours**

FIXED SPEED SYSTEMS

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model of wind turbine rotor - Drive Train model.

UNIT IV **9 Hours**

VARIABLE SPEED SYSTEMS

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V **9 Hours**

GRID CONNECTED SYSTEMS

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, Safety, Monitoring and Protection system, Harmonics and Power Quality-Wind Turbine as a Discrete Generator-Islanding.

Total: 45 Hours

Reference(s)

1. Earnest Joshua, "Wind Power Technology", PHI Learning, New Delhi, 2019, ISBN: 978-8120351660.
2. S.N.Bhadra, D.Kastha, S.Banerjee, " Wind Electrical Systems", Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2015.
4. Ahmad Hemami, "Wind Power Technology", Cengage Learning Series in Renewable Energy, 2012.
5. N. Jenkins, "Wind Energy Technology", John Wiley & Sons,2021.
6. Siegfried Heier, "Grid Integration of WECS", John Wiley & Sons Ltd, 2014.

22EE021 FUEL CELL SYSTEMS **3 0 0 3**

Course Objectives

- To understand the principles of fuel cell technology
- To understand the concept of fuel cell system components
- To differentiate and apply the working of different fuels cells.
- To analyse fuel cell system design and integration.
- To analyse the applications of fuel cell systems.

Programme Outcomes (POs)

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

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

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

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the concept of electrochemical reaction and analyze the performance of different fuel cells used in E vehicle applications.
2. Analyze the characteristics of electrodes, electrolytes and materials used for manufacturing a fuel cell.
3. Analyze the performance of different fuel cell system and select a method for optimized energy conversion.
4. Analyse the characteristics of fuel cells and select the type of fuel cell for residential and commercial applications.
5. Apply different testing methods and analyze the characteristics of fuel cells used in industrial applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Types of fuel cells: proton exchange membrane (PEM), solid oxide (SOFC), molten carbonate(MCFC), and phosphoric acid (PAFC) fuel cells-Working principles of fuel cells-Electrochemical reactions in fuel cells-Advantages and challenges of fuel cell technology

UNIT II **9 Hours**

FUEL CELL COMPONENTS AND MATERIALS

Electrodes and catalysts: types, characteristics, and selection criteria-Membranes and electrolytes: properties and considerations-Bipolar plates and current collectors-Gas diffusion layers and flow fields-Materials selection for fuel cell components-Durability and performance considerations

UNIT III **9 Hours**

FUEL CELL SYSTEMS AND DESIGN

System configurations: standalone, grid-connected, and hybrid systems-Balance of plant (BOP) components: compressors, humidifiers, heat exchangers, pumps, and control systems-System efficiency and optimization strategies-System integration and control-Safety considerations in fuel cell system design

UNIT IV **9 Hours**

FUEL CELL APPLICATIONS

Transportation applications: automotive, buses, and trains-Portable and off-grid power applications-Residential and commercial stationary power generation-Industrial and remote power systems-Emerging applications and market trends

UNIT V **9 Hours**

FUEL CELL PERFORMANCE, TESTING, AND CHARACTERIZATION

Fuel cell performance metrics: voltage-current characteristics, power density, and efficiency- Testing methodologies and protocols-Diagnosis and troubleshooting of fuel cell systems- Performance modelling and simulation-Lifetime and degradation analysis

Total: 45 Hours

Reference(s)

1. Ryan O'Hayre, Suk-Won Cha, Whitney Colella, and Fritz B. Prinz, “Fuel Cell Fundamentals”, PHI Learning, New Delhi, 2016
2. James Larminie and Andrew Dicks, “ Fuel Cell Systems Explained”, Latest edition: 2003.
3. Nigel Sammes and Ruud van Berkel, “Fuel Cell Technology: Reaching Towards Commercialization"”, (Latest edition: 2006).
4. Matthew M. Mench and Kwang J. Kim, “Fuel Cell Engines”, (Latest edition: 2008).
5. Ludwig Jörissen and Detlef Stolten, “Fuel Cells: Principles, Design, and Analysis”, (Latest edition: 2013)

22EE022 RENEWABLE ENERGY SYSTEM INSTALLATIONS AND MAINTENANCE **3 0 0 3**

Course Objectives

- To Understand the fundamental principles and components of solar energy systems
- To understand site assessment and design considerations
- To understand the electrical wiring and commissioning of solar energy systems
- To apply the concepts and methods for maintenance and troubleshooting
- To apply the principles and applications of off-grid and grid-tied solar energy systems.

Programme Outcomes (POs)

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the fundamental principles and analyze the performance of solar PV Module and array used in solar energy conversion system.
2. Analyse the parameters used in constructing a solar energy system and select the system for optimal power output.
3. Apply the rules, regulations and testing methods, for installation and commissioning of solar energy systems.
4. Apply safety measures for cleaning and maintenance and troubleshooting techniques of solar energy systems.
5. Analyse performance of an off grid and on grid tied solar energy 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	1	-	-	-	-	1	-	-	-	-	-	-	2
3	2	2	-	-	-	-	1	-	-	-	-	-	-	2
4	2	2	-	-	-	-	1	-	-	-	-	-	-	2
5	2	2	-	-	-	-	1	-	-	-	-	-	1	-

UNIT I **9 Hours**

INTRODUCTION

Basic parameters of solar PV Panels - Solar PV Systems: Array design - Module design- Battery sizing, Inverter and charge controller selection – Series and parallel connection of solar module and array.

UNIT II **9 Hours**

DESIGNING SOLAR ENERGY SYSTEMS

Site assessment and analysis for solar energy systems - Load estimation and energy consumption analysis - Sizing of solar energy systems based on energy needs - Placement and orientation of solar panels for optimal performance - Electrical design considerations: wiring, grounding, and safety.

UNIT III **9 Hours**

SOLAR ENERGY SYSTEM INSTALLATION

Preparing the site for installation: permits, regulations, and safety measures - Mounting and securing solar panels - Electrical wiring and connections - Installation of inverters, batteries, charge controllers, and other system components - Testing and commissioning the solar energy system

UNIT IV **9 Hours**

MAINTENANCE AND TROUBLESHOOTING

Regular maintenance practices for solar energy systems - Cleaning and inspection of solar panels - Monitoring and performance analysis - Identifying and addressing common issues and troubleshooting techniques - Safety precautions during maintenance activities.

UNIT V **9 Hours**

OFF-GRID AND GRID-TIED SYSTEMS

Off-grid solar energy systems: design and installation considerations - Battery storage systems: types, sizing, and maintenance - Grid-tied solar energy systems: connecting to the electrical grid - Net metering and feed-in tariffs - Backup power options and emergency preparedness

Total: 45 Hours

Reference(s)

1. Muhammad H., “Photovoltaic Systems: Analysis and Design”, Year: 2018
2. Michael Boxwell, “Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy”,2020
3. Sean White "Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification",2015.
4. Chetan Singh Solanki "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers, and Engineers",2012
5. Majid Ghassemi & Robert Foster, "Solar Energy: Renewable Energy and the Environment",2018.

22EE023 ENERGY STORAGE SYSTEMS 3 0 0 3

Course Objectives

- Understand the significance of energy storage schemes.
- Understand the working of two types of mechanical energy storage systems
- Understand the concepts of various models of batteries
- Understand the performance of passive energy storage elements.
- Understand the principles of different methods of thermal energy storage schemes

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the importance of energy storage systems for thermochemical and organic fuel systems.
2. Analyze the principles of mechanical energy storage systems for industrial applications.
3. Apply electrochemical concepts to evaluate the performance of primary and secondary battery systems.
4. Analyze the performance characteristics of electromagnetic energy storage systems for real time applications.
5. Apply thermal energy storage methods to assess environmental impacts and practical benefits.

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

UNIT I **8 Hours**

MODES OF STORAGE

Need and importance of Energy storage, Periodic Storage, Modes of Storage: Thermo-chemical energy storage, Energy Storage in Organic Fuels, Hydrogen Storage, Bio Fuel Cell and Green Battery storage.

UNIT II **9 Hours**

MECHANICAL ENERGY STORAGE

Introduction - Potential Energy Storage - Energy Storage in Pressurized Gas - Pumped-Hydro Storage - Kinetic Energy in Mechanical Systems - Linear and Rotational Kinetic Energy - Internal Structural Energy Storage, Applications

UNIT III **10 Hours**

ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

Fundamental concepts - Reaction Mechanisms in Electrochemical Cells - Practical Parameters, Equivalent Circuit, Types of batteries: Primary, Secondary, Lithium, Solid-state and molten solvent, lead acid, Nickel Cadmium Batteries; Zinc Manganese dioxide, Applications.

UNIT IV **9 Hours**

ELECTROMAGNETIC ENERGY STORAGE SYSTEMS

Superconducting Magnet Energy Storage (SMES) systems, Energy in a Material in a Magnetic Field, Superconductive Materials, Super capacitor: Electrochemical Double Layer Capacitor (EDLC): principle of working, structure, performance and applications

UNIT V **9 Hours**

THERMAL ENERGY STORAGE

Basic Principles - Benefits - Methods - Sensible Thermal Energy Storage (TES)- Latent TES - Cold TES - Seasonal TES - Thermal Energy Savings - Environmental Impacts - Applications.

FURTHER READING

Ocean wave energy - conversion, principle, power plants, tidal energy conversion, Scope and development

Total: 45 Hours

Reference(s)

1. S.R. Khalid, " Energy Storage Systems: Operation and Control", CRC Press, 1st Edition, 2020.
2. Bengt Sunden and Mohammad Reza Ghalambor, "Handbook of Energy Storage: Types, Technologies and Applications", Springer, 1st Edition, 2019.
3. Huggins, Robert A., Energy Storage: Fundamentals, Materials and Applications, Second Edition, Springer US, 2015.
4. Ibrahim Dincer,Mark A. Rosen, Thermal Energy Storage Systems and Applications, 2nd Edition, Wiley, 2011.
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, First, Wiley publications, 2012.

22EE024 GRID INTEGRATION OF RENEWABLE SOURCES 3 0 0 3

Course Objectives

- To understand the operation of grid interconnected renewable energy systems.
- To identify the grid integration issues.
- To understand the grid integration of PV system.
- To understand the grid integration of wind system.
- To understand the Integration of alternate sources of energy.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the challenging factors and constraints for renewable energy integration to grid system.
2. Analyze the stability, power quality issues related to grid interconnection and its impact with NCE sources.
3. Analysis the control methods of PV interconnections with power system and select the method suitable for solar PV generating stations.
4. Analysis the current techniques of wind interconnections with power system and select the technique to get optimal power.
5. Analysis the converting technologies and control methods for integrating multiple renewable energy sources.

Articulation Matrix

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

UNIT I 9 Hours
INTRODUCTION

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid - Qualitative analysis - Grid Interactive Inverters-matrix converters.

UNIT II **9 Hours**

IMPACT OF GRID INTEGRATION

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT III **9 Hours**

GRID INTEGRATION OF PV SYSTEMS

Grid-Connected PV Power Systems - Inverter Control Algorithms - Synchronous Reference Frame–Based Current Controller - Digital PI-Based Current Controller - Adaptive Notch Filter-Based Grid Synchronization - Modeling, Simulation, and Hardware Implementation of Controllers

UNIT IV **9 Hours**

GRID INTEGRATION OF WIND SYSTEMS

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

UNIT V **9 Hours**

INTEGRATION OF ALTERNATE SOURCES OF ENERGY

Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection

Total: 45 Hours

Reference(s)

1. Marco H. Balderas, ‘Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Majid Jamil, M. Rizwan, D.P.Kothari, ‘Grid integration of solar photovoltaic systems’, CRC Press, NewYork, 2017.
3. B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O Malley, R. Watson and D. Milborrow, ‘Wind Power Integration connection and system operational aspect, 1st Edition, IET Power and Energy Series 50, 2007.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.
5. Felix A. Farret and M. Godoy Simoes, ‘Integration of Alternative sources of Energy’, 1st Edition, IEEE Press – Wiley-Interscience publication, 2006.

22EE044 HYDROGEN GENERATION AND STORAGE

3 0 0 3

Course Objectives

- Understand the basic properties of hydrogen.
- Select a suitable hydrogen generation technique.
- Select a suitable hydrogen storage technique.
- Analyze the economic viability and environmental impact of hydrogen generation and storage systems.
- Understand the safety considerations and regulations related to hydrogen handling.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the basic of thermodynamics and analyze the chemical and physical characteristics of Hydrogen used in storage systems.
2. Analyze the hydrogen generation technique based on the mechanisms, performance characteristics, and applicability.
3. Analyze the hydrogen storage technique based on the mechanisms, performance characteristics, and applicability.
4. Analyze the economic viability and environmental impact of hydrogen generation and storage systems.
5. Apply the safety measures and regulations related to hydrogen generation and storage systems for effective utilization.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Basic Properties of Hydrogen, Engineering Thermodynamics, Hydrogen and Environment, Hydrogen and Sustainability, Hydrogen Production Methods, Green Hydrogen Sources, Hydrogen as an Energy Carrier, Historical Background and Current Applications.

UNIT II **9 Hours**

HYDROGEN GENERATION METHODS

Steam methane reforming, Electrolysis (alkaline, PEM, and solid oxide electrolysis), Coal/Biomass Gasification, Solar and Wind-based Hydrogen Production, Emerging Hydrogen Generation Technologies.

UNIT III **9 Hours**

HYDROGEN STORAGE TECHNIQUES

Compressed Gas Storage, Liquid Hydrogen Storage, Chemical Storage (hydrogenation, metal hydrides), Physical Storage Using Nanostructured and Porous Materials, Underground Hydrogen Storage, Emerging Hydrogen Storage Technologies.

UNIT IV **9 Hours**

PERFORMANCE AND EFFICIENCY

Efficiency Considerations in Hydrogen Generation, Energy Losses and Efficiency of Different Storage Methods, Performance Assessment of Hydrogen Production and Storage Systems.

UNIT V **9 Hours**

SAFETY AND REGULATIONS

Safety Considerations in Hydrogen Handling and Storage, Codes and Standards for Hydrogen Storage Systems, Risk Assessment and Mitigation Strategies, Case Studies of Hydrogen-related Incidents.

Total: 45 Hours

Reference(s)

1. Zhang, J. Z., Li, J., Li, Y., Zhao, Y., Hydrogen Generation, Storage and Utilization, John Wiley & Sons, 2014.
2. Dinçer, I., Zamfirescu, C., Sustainable Hydrogen Production, Elsevier, 2016
3. Iulianelli, A., Basile, A., Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2014.
4. Altalhi, T. A., Adnan, S. M., Amin, M. A., Materials for Hydrogen Production, Conversion, and Storage, John Wiley & Sons, 2023.
5. Sherif, S. A., Goswami, D. Y., Stefanakos, E. L., Steinfeld, A., Handbook of Hydrogen Energy, CRC press, 2014.

VERTICAL V - EMBEDDED SYSTEM DESIGN

22EE025 ADVANCED PROCESSOR ARCHITECTURES 3 0 0 3

Course Objectives

- To introduce the concept of RISC and CISC microcontrollers.
- To analyze the principles of parallel processing.
- To understand the concept of shared memory architecture in multiprocessing.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5.Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Implement multiprocessor cache mapping techniques, cache coherence and memory consistency models.
2. Analyze the RISC processor and interface with PIC microcontroller and various peripherals.
3. Analyze 16bit microcontroller RL78 and design microcontroller based systems for a Real Time application.
4. Apply various types of pipelining methodologies.
5. Analyze the concept of parallel architecture and programming.

Articulation Matrix

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

UNIT I **9 Hours**

PROCESSORS AND MEMORY HIERARCHY

Advanced processor Technology, Super scalar and vector processor, Memory hierarchy technology, Virtual Memory Technology.

UNIT II **9 Hours**

RISC PROCESSOR

RISC Vs CISC, RISC properties and evolution, Advanced RISC microcontrollers, PIC18xx microcontroller family, Architecture, Instruction set, ROM, RAM, Timer programming Serial port programming, Interrupt programming, ADC and DAC interfacing, CCP module and programming.

UNIT III **9 Hours**

CISC PROCESSORS

RL78 16 BIT Microcontroller architecture, Addressing modes, On Chip memory, ADC, Interrupts, MAC unit, Barrel shifter, Internal and external clock generation, Memory CRC, On chip debug function and self programming.

UNIT IV **9 Hours**

PIPELINING AND SUPERSCALAR TECHNIQUES

Linear Pipeline, Nonlinear pipeline, Instruction pipeline, Arithmetic pipeline, Superscalar and super pipeline design, Parallel and scalable architectures, Multiprocessor and Multicomputer.

UNIT V **9 Hours**

PARALLEL ARCHITECTURE AND PROGRAMMING

Overview of parallelism, Basic concepts in parallel programming, Microprocessor design phases and trends, Categorizations of multicore architectures, Multicore parallel processing models, Parallelization of programs, Levels of parallelism: Instruction level parallelism and Data level parallelism.

Total: 45 Hours

Reference(s)

1. Hwang. K, Advanced computer Architecture, Parallelism, Scalability, Programmability, Tata McGraw Hill, 3rd Edition, 1993.
2. Alexander G, James M. Conard, Creating fast, Responsive and energy efficient Embedded systems using the Renesas RL78 microcontroller, Micrium press, USA, Reprinted by S.P Printers, 2011.
3. V.Rajaraman and C.Siva Ram Murthy, Parallel Computers Architecture and Programming, PHI, 2000.
4. Quinn, M.J., Designing Efficient Algorithms for Parallel Computers, McGraw - Hill, 2003.
5. Muhammad Ali Mazidi, Rolind D. Mckinlay and Danny Causey. PIC Microcontroller and Embedded Systems, Pearson Education, 2008.
6. Darryl Gove, Multicore Application Programming: for Windows, Linux, and Oracle Solari, Pearson Education Inc., 2011.

22EE026 COMMUNICATION PROTOCOLS AND STANDARDS

3 0 0 3

Course Objectives

- To analyze the components and need for communication in ECU
- To analyze the functions and frame format of CAN protocols
- To analyze the concept of LINBus, MODbus and Flex Ray protocols
- To analyze the functions of OBD communication in inter vehicle communication
- To understand the Autosar Standard and its architecture

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5.Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Select the suitable ECU components for different communication
2. Analyze the performance of CAN protocols
3. Analyze the performance of LINBus, MODbus and Flex Ray protocols
4. Analyze the architecture of OBD communication
5. Analyze the architecture of Autosar Standard

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to ECU Functions and Components , Need for Communication in ECU , Types of Communication Onboard Communication, Diagnostic Communication, Measurement and Calibration , Protocols and Comparison to ISO OSI, In Vehicle Cybersecurity Issues and Challenges

UNIT II **9 Hours**

CAN FUNDAMENTALS

Introduction to CAN , Electrical properties-CAN signaling and data rates,CAN data frame format, CAN controller block diagram and working,CAN driver configurations,Software for CAN controller interfacing-CAN development tools

UNIT III **9 Hours**

LINBUS, AND MODBUS, FLEX RAY

LIN bus , basics LIN bus protocol,master slave configuration , Basics of MODBUS , MODBUS protocol , MODBUS application , Flex ray and Automotive Ethernet Introduction and Usage, CAN vs Automotive Ethernet

UNIT IV **9 Hours**

HIGH-LEVEL COMMUNICATION PROTOCOLS

Onboard Communication J1939 ,Introduction , Key Characteristics , J1939 Standard and Layer Model , J1939 PGN and SPN , J1939 Transport Protocol , OBD II , OBD vs ISO OSI Layers , OBD Connectors , OBD Services , OBD Parameter ID (PIDs) , OBD Connectors

UNIT V **9 Hours**

AUTOSAR ARCHITECTURE

Introduction to Autosar Standard and Consortium , Need for Autosar Architecture , Virtual Function Bus , Layered Architecture Model, Microcontroller Abstraction Layer , ECU Abstraction Layer , Service layer , Autosar example

Total: 45 Hours

Reference(s)

1. Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Embedded networking with CAN and CANopen, Copperhill Technologies Corporation, 2008
2. Reference: www.can cia.org
3. SGS-Thompson, Lin Application note AN1278, SGS Thompson Ltd. 2002
4. Modbus-IDA, MODBUS application protocol specification, ModbusIDA, 2006
5. Siemens, Profibus network manual, Simens manual, 2009
6. Xiu Ji, Profibus in practice: System Architecture and Design, CRC press, 2015

22EE027 EMBEDDED C PROGRAMMING 3 0 0 3

Course Objectives

- To expose the students to the fundamentals of C Programming
- To familiarize the students with data structures concepts
- To introduce the students basic Linux concepts
- To involve the students to familiarize with SHELL programming
- To implement the device drivers in LINUX environment

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyze the fundamentals of C and Data Structures
2. Analyze the basics of LINUX and SHELL programming
3. Analyze the basic knowledge of Embedded Linux
4. Apply the concepts of Kernel Module Programming
5. Implement Device Drivers programs and hands on experience in using state-of-art hardware and software tools

Articulation Matrix

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

UNIT I **9 Hours**

C LANGUAGE AND DATA STRUCTURES OF KERNEL PROGRAMMING

Basic Concepts of C, Embedded C Vs C, Embedded Programming aspects with respect to firmware and OS Functions, Arrays, Pointers, Structures and Inputs/Outputs. Linked List, Singly Linked List, Doubly Linked List, Queues.

UNIT II **9 Hours**

LINUX AND SHELL PROGRAMMING

Command prompt, X windows basics, navigating file system, Finding Files, working with folders, Reading files, Text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/O Handling, File Locking. Processes, Prioritizing and killing processes, Scheduling Commands, Pipes and redirection, Regular expression, Pattern Matching, Scripting using for, while, if and other commands.

UNIT III **9 Hours**

EMBEDDED LINUX

Linux Basics, Booting process, Make files using SD card reader to transfer program. Introduction to Linux system calls, API"s, device drivers, compiling and installing a device driver.

UNIT IV **9 Hours**

KERNEL MODULE PROGRAMMING

Compiling kernel, configuring kernel and compilation, Kernel code, Browsers, Static linking, Dynamic linking of modules, User space, Kernel space concepts, writing simple modules, Writing, Make files for modules.

UNIT V **9 Hours**

DEVICE DRIVER CONCEPTS

Driver concepts, Block and character driver distinction, Low level drivers, OS drivers etc, writing character drivers, Device major, minor number.

Total: 45 Hours

Reference(s)

1. Neil Mathew, Richard stones, Beginning Linux Programming, 2012 reprint, Wrox-Wiley Publishing, USA.
2. Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, reprint, Wrox-Wiley Publishing, USA
3. Derek Molloy, Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux, 2015, 1st Edition, Wiley Publications, USA

22EE028 REAL TIME OPERATING SYSTEMS 3 0 0 3

Course Objectives

- To expose the students to the fundamentals of interaction of OS with a computer and User computation.
- To teach the fundamental concepts of how process are created and controlled with OS.
- To study programming logic of modeling Process based on range of OS features.
- To compare types and Functionalities in commercial OS, application development using RTOS.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired.

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5.Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze Operating System structures and types.
2. Analyze the operating systems tasks and its assess to the resources.
3. Analyze the scheduling, disciplining of various processes execution.
4. Demonstrate commercial RTOS Suite features to work on real time processes design.
5. Develop Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

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

UNIT I **9 Hours**

INTRODUCTION TO OPERATING SYSTEMS

Basic Principles, Operating System structures, Operating Systems functions, System Calls, Files, Processes, Design and Implementation of processes, Communication between processes, Introduction to Distributed operating system, Embedded operating systems.

UNIT II **9 Hours**

OVERVIEW OF RTOS

RTOS Task and Task state, Process Synchronization, Message queues, shared memory, Mail boxes, pipes, Critical section, Semaphores, mutex, priority inversion and ceiling, circular and swinging buffers.

UNIT III **9 Hours**

TASK MANAGEMENT AND RTOS SCHEDULING

Process and Threads, Process Control Block, Process Attributes, Interrupt processing, memory management, Priority based scheduling, Rate-Monotonic scheduling, Earliest Deadline first scheduling

UNIT IV **9 Hours**

REALTIME KERNEL

Principles, Kernel, Monolithic and Microkernel, Design issues, Polled Loop Systems, RTOS Porting to a Target, Comparison and Basic study of various RTOS like VX works Linux supportive RTOS.

UNIT V **9 Hours**

APPLICATION DEVELOPMENT

Discussions on Basics of Linux supportive RTOS, uCOS-C Executive for development of RTOS Application, Case study.

Total: 45 Hours

Reference(s)

1. Herma K., Real Time Systems, Design for distributed Embedded Applications, 2011, 2nd edition, Springer, USA
2. Tanenbaum, Andrew, Modern Operating Systems, 2015, 4th ed., Pearson Prentice Hall, USA.
3. Ivan CibrarioBertolotti, Politecnico di Torino and Gabriele Manduchi, Real-Time Embedded Systems: Open-Source Operating Systems Perspective, 2012, 1st ed., CRC Press, USA.
4. Lyla B. Das, Embedded Systems an Integrated Approach, 2012, 1st ed., Pearson Education, India.
5. Karim Yaghmour,Building Embedded Linux System,O reilly Pub,2003
6. MukeshSighal and N G Shi, Advanced Concepts in Operating System, McGraw Hill,2000

22EE029 EMBEDDED LINUX 3 0 0 3

Course Objectives

- To understand the concept of embedded linux and desktop linux
- To Configure Linux environment and Tool-Chain
- To Demonstrate Linux Booting Process and to configure Linux Kernels

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyze the concepts of embedded Linux development model.
2. Construct a Linux Board Support Package and storage for a hardware platform
3. Analyze the features and internal architecture of kernel and tool chain
4. Analyze the porting issues in Linux Environment.
5. Apply the various development tools to customize the embedded linux application.

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

UNIT I **9 Hours**

INTRODUCTION

History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux StartUp Sequence

UNIT II **9 Hours**

LINUX FUNDAMENTALS

Board Support Package: Inserting BSP in Kernel Build Procedure, Boot Loader Interface, Memory Map, Interrupt Management, PCI Subsystem

Embedded Storage: Flash Map, MTD : Memory Technology Device, MTD Architecture, MTD Block and Character devices, Optimizing Storage Space.

UNIT III **9 Hours**

ARCHITECTURE OF EMBEDDED LINUX

Kernel Architecture, Kernel Functional Overview, Commands in Linux, Configuring the Linux Environment, Tool-chain: Configuration and Cross-Compilation, Linux Bootloader & U-Boot, Embedded Linux Kernel, Building Root File System.

UNIT IV **9 Hours**

PORTING APPLICATIONS

Architectural Comparison, Application Porting Road Map, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver

UNIT V **9 Hours**

DEVELOPMENT TOOLS

Embedded development environment, GNU debugger, tracing & profiling tools, binary utilities, kernel debugging, debugging embedded Linux applications, porting Linux, Linux and real time, SDRAM interface

Total: 45 Hours

Reference(s)

1. Chris Simmonds "Mastering Embedded Linux Programming", Second Edition, PACKT Publications Limited. 3rd Edition, 2021.
2. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded Linux systems", O Reilly, 2008.
3. P Raghvan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications, 2019.
4. Christopher Hallinan, "Embedded Linux Primer: A Practical Real World Approach", Prentice Hall, 2nd Edition, 2010
5. Derek Molloy, "Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux", Wiley, 1st Edition, 2014.
6. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", Prentice Hall, 2007

22EE030 VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS

3 0 0 3

Course Objectives

- To develop graphical programming environment in Virtual Instrumentation
- To develop skills in data acquisition, instrumentation and control.
- To develop Virtual Instruments system for the Real-Time applications

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solvecomplex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the concepts of traditional instruments and virtual instruments
2. Analyze the overview of modular programming and the structuring concepts in VI programming
3. Develop the procedure to install DAQ in various OS and its interfacing methods
4. Develop virtual instrument using NI software and hardware
5. Analyse the performance of signal processing tool kits in virtual instrumentation

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, Conventional Instruments versus Traditional Instruments, data-flow techniques, Editing Debugging and Running a Virtual Instrument- Graphical programming palettes and tools - Front panel objects.

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING ENVIRONMENT IN VI

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures-Arrays and Clusters- Array operations - Bundle, Unbundle - graphs and charts - string and file I/O - High level and Low level file I/Os - local and global variables - VIs and sub-Vis.

UNIT III **9 Hours**

DATA ACQUISITION

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Digital and Analog I/O function - Buffered I/O - counters and timers, Data acquisition interface requirements, Issues involved in selection of Data acquisition cards.

UNIT IV **9 Hours**

VI IN EMBEDDED SYSTEM

Laboratory Virtual Instrumentation and Engineering Workbench (LabVIEW) - NI Multisim - NI ELVIS III Hardware - MyDAQ: Measurements & datalogging - MyRIO: Embedded Monitoring & Control - 5G wireless communication: NI SDR Hardware bundle for RF & Wireless communication system design - PCI, PXI system controllers, Ethernet control of PXI.

UNIT V **9 Hours**

ANALYSIS TOOLS AND APPLICATIONS

Fourier transform - Power spectrum - Filtering tools - CRO emulation - Audio signal processing using Signal processing toolkit - Virtual instrumentation application in Biomedical, Process Control and Mechatronics.

Total: 45 Hours

Reference(s)

1. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
2. Behzad Ehsani , Data Acquisition Using LabVIEW, Packt Publishing, 2016
3. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
4. Nitesh Pradhan CLAD Preparation Book, Blue Rose Publishers, 2020.
5. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

22EE031 UTILIZATION OF ELECTRICAL ENERGY 3 0 0 3

Course Objectives

- To understand the definitions for illumination and types of lamps.
- To Maintain different types of electrical utilities and systems.
- To look over the Electric drives for traction.
- To understand the Electric drives for elevators.
- To analyze the tariff and power factor improvement for all types of supplies.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the functioning of different types of lamps, laws and fittings.
2. Analyze different electric heating methods and different welding equipment.
3. Analyze different types of electric drives and elevators.
4. Apply the different electric traction systems and speed calculations.
5. Apply the tariffs for various schemes and analyze equipment for power factor improvement.

Articulation Matrix

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

UNIT I **9 Hours**

ILLUMINATION

Illumination terminologies, Laws of Illumination, Inverse square law and Lamberts cosine law, Various types of lamps, LED lamps, Various lighting schemes: features and application, Domestic and industrial lamp fittings, Electronic ballast.

UNIT II **9 Hours**

ELECTRIC HEATING AND WELDING SYSTEMS

Concept of electrical heating, classification of electric heating, Induction heating, Dielectric heating, Types of welding systems, Arc welding, Supply requirements; AC welding machines, welding transformer, safety precautions

UNIT III **9 Hours**

ELECTRIC DRIVES AND ELEVATORS

Electric Drives, Transmission of mechanical power, Bearing, Size and rating of motor, Definition of standard rating as per IS, Load cycles, Load Equalization, Braking, Elevators, Factors on which shape and size of car depends, Bombay Lift Act 1939. (Latest Amendment).

UNIT IV **9 Hours**

ELECTRIC TRACTION

Requirements of an ideal traction system, different types of traction system used in India, Traction mechanics, Traction motors, Definition of average and schedule speed, factors affecting schedule speed, Speed, time curve, Current collecting System: Pantographs.

UNIT V **9 Hours**

TARIFF AND POWER FACTOR IMPROVEMENT

Tariff: Desirable characteristics, types, Power factor, Power factor improvement using; static capacitor, most economical power factor, location of power factor improvement, Devices from consumer and electrical supply company point of view.

Total: 45 Hours

Reference Book(s)

1. Pratap H, “Art and Science of Utilization of Electrical Energy” ,Dhanpat Rai &Sons, New Delhi, 2017.
2. Gupta J B “Utilization of Electric Power and Electric Traction”, S. K. Kataria & Sons, New Delhi, 2016.
3. Garg “Utilization of Electric Power and Electric Traction”, G. C. Khanna Publishers, NewDelhi, 2016,
4. Upadhyay J, Mahendra S N, “Electric Traction”, Allied Publisher Ltd., New Delhi, Latest edition .
5. Dubey G, “Fundamentals of Electrical Drives”,G. K. Narosa Publishing House. New Delhi, Latest edition.
6. Mehta V K, “Principles of Power system, S.Chand, New Delhi, Latest edition

22EE032 INDUSTRIAL ELECTRONICS

3 0 0 3

Course Objectives

- To study about the physical phenomena of different types of sensors.
- To understand about the measuring principal of MEMS devices and technologies.
- To understand about the MEMS devices and technologies and applications.
- To study about the role of FPGA in industrial applications.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyse the Fundamental physical phenomena of sensors and characteristics of transducers.
2. Apply the characteristics of Advanced Sensor Technology their corresponding application domains .
3. Analyse the fundamentals of MEMS technologies and its application in industrial devices.
4. Evaluate the types and working principles of micro sensors
5. Analyse the role of FPGA in reconfigurable systems.

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF SENSORS AND TRANSDUCERS

Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analogto digital converter, digital to analog converter.

UNIT II **9 Hours**

ADVANCED SENSOR TECHNOLOGIES

Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders, colour sensors, sensing principles, colour theory, unit colour measurement, colour comparator, colour sensing algorithm, fuzzy logic colour sensor. fuzzy logic for opt-electronic colour sensor in manufacturing.

UNIT III **9 Hours**

MEMS TECHNOLOGIES AND APPLICATIONS

Introduction to Microsystems and microelectronics - Applications of micro system in automotive - bio medical - aerospace - telecommunication industries. Trimmer's scaling vector and scaling laws, Materials for MEMS-Deposition - Etching-Molding.

UNIT IV **9 Hours**

MICRO SENSORS

Microsensors - Types of micro sensors - Micro accelerometer, Pressure sensors and thermal sensors. Micro actuation techniques - piezoelectric crystals - Shape memory alloys - bimetallics - conductive polymers. Micro motors - micro grippers - Microfluidic devices - Micro pumps - micro valves - valve less micro pumps.

UNIT V **9 Hours**

FPGAS AND RECONFIGURABLE SYSTEMS

Introduction-advanced Hardware resources in FPGAs-Software tools for FPGAs-role of FPGAs in reconfigurable Systems-applications.

Total: 45 Hours

Reference(s)

1. Maloney, Timothy, "Modern Industrial Electronics", Upper Saddle River: Prentice Hall. 2015.
2. A.K.Sawhney and P.Sawhney, "A Course on Mechanical Measurement Instrumentation and Control", Dhanpat Rai and Co, New Delhi, 2017
3. Tai Ran Hsu, "MEMS and Micro Systems Design and Manufacture", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
4. Rehg, James, A., Sartori, Glenn," Industrial Electronics", Upper Saddle River: Prentice Hall. 2016.
5. G.K.Mithal,"IndustrialElectronics",Khanna Publishers,Delhi, 2016.

22EE033 ILLUMINATION ENGINEERING 3 0 0 3

Course Objectives

- To impart basic knowledge on Illumination.
- To understand the types of sources and accessories used in lighting.
- To understand the measurement techniques of illumination and its parameters.
- To illustrate the design procedures applicable for interior lighting.
- To illustrate the design procedures applicable for exterior lighting.

Programme Outcomes (POs)

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

Course Outcomes (COs)

1. Analyse the basic concepts and characteristics of lighting.
2. Apply the control technique based on the selection of lighting requirement.
3. Analyse the various parameters of illumination and their measuring techniques.
4. Apply the lighting procedure for designing exterior environments.
5. Apply the lighting procedure for designing interior environments.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Light and Lighting, Basic Concepts and Units, Photometry and Measurement, Quantity and Quality of Lighting. Factors affecting lighting, artificial lighting, Lighting scheme.

UNIT II **8 Hours**

ACCESORIES

Light sources: Daylight, Incandescent, Electric Discharge, Fluorescent, Arc lamps, Lasers, Neon signs, Energy Efficiency, LED - LCD displays, Luminaries, Wiring, Switching, Control circuits.

UNIT III **10 Hours**

CALCULATION AND MEASUREMENT

Luminance measurement, Effect of voltage variation, Lighting calculations and characteristic curves, Solid angle, Inverse square and cosine laws, Illumination from point, line and surface sources, Photometry and Spectro - photometry, photocells.

UNIT IV **10 Hours**

INTERIOR LIGHTING

Lighting design procedure for Industrial, Residential, Office, Departmental stores, Indoor stadium, Theatres and Hospitals-Energy Efficient Lighting.

UNIT V **10 Hours**

EXTERIOR LIGHTING

Environment and glare, Lighting Design procedure for Flood, Street, Sport, Aviation and Transport lighting, Lighting for Displays and Signalling-Energy Efficient Lighting.

Reference(s)

Total: 45 Hours

1. Joseph B. Murdoch, Illumination Engineering from Edicoan Lamp to the Laser, Vision Communications, Washington DC, USA, 1994
2. Jack L. Lindsey, Applied Illumination Engineering, Prentice Hall of India, New Delhi, 2008.
3. Marc Schiler, Simplified Design of Building Lighting, John Wiley and Sons, 1997.
4. IES Lighting Handbook, 1993.
5. D.C. Pritchard, Lighting, Routledge, 6th Edition, 2016

22EE034 ELECTRICAL SAFETY 3 0 0 3

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety.
- To understand the causes of accidents due to electrical hazards.
- To know the various protection systems in Industries from electrical hazards.
- To know the importance of earthing.
- To distinguish the various hazardous zones and applicable fire proof electrical devices.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Evaluate the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Analyze the different hazardous zones in Industries and apply their safety measures.

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

UNIT I **9 Hours**

CONCEPTS AND STATUTORY REQUIREMENTS

Review of Electrical concept - electrostatics, electro magnetism, stored energy - working principles of major electrical equipment - Indian electricity act and rules - statutory requirements from electrical inspectorate- international standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards - Energy leakage - clearances and insulation - current surges - electrical causes of fire and explosion - national electrical safety code ANSI- Lightning hazards.

UNIT II **9 Hours**

PROTECTION SYSTEMS

Fuse, circuit breakers and types - protection against over voltage and under voltage - safe limits of amperage – safe distance from lines - overload and short circuit protection - earth fault protection. - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

SELECTION, INSTALLATION, OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance.

UNIT V **9 Hours**

HAZARDOUS AREAS

Hazardous area classification and classification of electrical equipment for hazardous areas (IS, API and OSHA standards)- classification of equipment/enclosure for hazardous locations.

Total: 45 Hours

Reference(s)

1. Fordham Cooper, W., "Electrical Safety Engineering, Butterworth and Company", London, Third Edition,2013.
2. "Indian Electricity Act and Rules", Government of India.
3. "Power Engineers", Handbook of TNEB, Chennai, 2010.
4. "Accident prevention manual for industrial operations", N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, "Electrical Safety Handbook",Fourth Edition, Tata Mcgraw Hill, 2014.

22EE035 ENERGY AUDITING AND MANAGEMENT 3 0 0 3

Course Objectives

- To understand the Indian energy scenario and international energy policies.
- To study the energy utilization of electrical systems.
- To analyse the energy audit techniques by using suitable tools and energy balance.
- To study the energy management features and audit procedure.
- To gain the knowledge on financial management in energy audit.

Programme Outcomes (POs)

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

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

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

PO7.Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development PO11.Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the importance of energy policies, energy conservation act features and energy security.
2. Apply the different energy conservation technique involved in electrical and electromechanical devices.
3. Apply the suitable energy audit technique using appropriate tools to improve the system efficiency with mass and energy balance concept.
4. Analyze the suitable energy audit technique, procedure and bench marking in energy audit.
5. Analyze the energy conservation opportunities and the various financial technique adopted in energy management.

Articulation Matrix

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

UNIT I **10 Hours**

ENERGY SCENARIO AND ENERGY POLICY

Role of energy in economic development and social transformation- Indian energy scenario- Energy statistics 2021-international energy policies-G20 and OPEC countries - Need for use of new and non-renewable Energy-Energy conservation act-2001 & its features - Energy Security.

UNIT II **8 Hours**

ELECTRICAL ENERGY UTILITY SYSTEM

Transmission and Distribution Losses-Transformer losses - Electricity Tariff- Load management and maximum demand control- Electric motor-losses in induction motor- efficiency calculation-factors affecting motor performance-power factor - energy efficient motors.

UNIT III **7 Hours**

ENERGY AUDIT INSTRUMENTS AND ENERGY BALANCE

Electrical measurements- Instruments used in energy audit: Wattmeter - flue gas analysers- PQ analyzers- infrared Thermography-Energy efficiency calculation in lighting, pump Applications-Material balance- energy balance - features

UNIT IV **10 Hours**

ENERGY MANAGEMENT AND AUDIT

Definition and objective of energy management - Principle of energy management - Key elements of energy management -Roles and responsibilities of energy manager - energy audit definition -types- Detailed energy audit procedure- understanding energy cost -Bench marking.

UNIT V **10 Hours**

EVALUATION OF SAVING OPPORTUNITIES AND FINANCIAL MANAGEMENT

Determination of cost saving -conservation opportunities - Estimating cost of implementation -Financial analysis techniques-plant energy audit report - Simple payback period, Return on investment, Net present value, Internal rate of return.

FOR FURTHER READING

Energy conservation and management -case studies - BEE rules and regulations.

Total: 45 Hours

REFERENCE(S)

1. Jose Golden Berg, Thomas Johansson, A K N Reddy, Robert Williams "Energy for a sustainable world", WileyEastern, 1988.
2. BEE reference book 1/2/3/4
3. Albert Thumann,Terry Niehus "A Handbook of Energy Audits", Ninth Edition, 2012.
4. Charles E Brown, "World Energy Resources", Springer, 2012.

22EE036 PLC and SCADA 3 0 0 3

Course Objectives

- To understand the architecture of PLC
- To understand the PLC programming using ladder logic and instructions
- To develop a real time models using PLC for required applications.
- To understand the architecture and types of SCADA
- To interface the PLC with SCADA

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3.Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6.The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the network and communication devices for interfacing computer with PLC.
2. Analyse the different programming languages used in PLC.
3. Apply the suitable logic for the particular industrial application.
4. Analyse the architecture of SCADA and its types.
5. Apply the Supervisory Control and Data Acquisition for the particular industrial application.

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

UNIT I **8 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC

UNIT II **10 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User, bit, branch and internal relay instruction -Boolean logic - Latching –Timers and Counters. Instructions in PLC: Program Control, Math, Data Manipulation – Sequencer, Shift register and Analog Instructions.

UNIT III **9 Hours**

APPLICATIONS OF PLC

Case Studies: Motor control- Bottle filling system - Pick and place robot - Car Parking - Traffic light control- Elevators - Pneumatic stamping system - alarm control system.

UNIT IV **8 Hours**

INTRODUCTION SCADA

Supervisory Control and Data Acquisition-Architecture/block diagram, Benefits of SCADA Types of SCADA- SCADA System Hardware -Remote terminal unit-Master terminal unit-Data Storage- Application area of SCADA.

UNIT V **10 Hours**

SCADA INTERFACING AND APPLICATIONS

Connection Diagram - Object Linking and Embedding for Process control architecture – Steps in creating SCADA- Steps for Linking SCADA Object with PLC using OPC- Concept of Tag, Applications of SCADA: On-off Control Lamp, Traffic Light Control– Elevator system – conveyor system

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, “Programmable Logic Controllers”, Tata Mc-Graw Hill, Third edition, 2015
2. John W Webb and Ronald A Resis, “Programmable Logic Controller”, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
3. Hackworth, John Hackworth, “Federic Programmable logic controllers”, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
4. Katariya Sanjay B, **“**Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments”, Notion Press; 1st edition, 2020.
5. Bailey David, Wright Edwin, “Practical SCADA for Industry”, Elsevier Publication 2003.

22EE037 ARTIFICIAL INTELLIGENCE IN ELECTRICAL ENGINEERING 3 0 0 3

Course Objectives

- To understand the models of artificial neural networks.
- To understand the deep learning methodologies
- To understand the concept of fuzzy logic principles.
- To understand the Genetic Algorithm and Particle Swarm Optimization.
- To apply the machine learning and deep learning techniques for practical applications

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the concept of fuzzy logic in Electrical systems.
2. Analyze the Genetic and Particle Swarm Optimization algorithms.
3. Analyze the various artificial neural network algorithms.
4. Analyze the different methodologies used in deep learning
5. Apply the various artificial intelligence techniques in electrical systems.

Articulation Matrix

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

UNIT I **9 Hours**

FUZZY SET THEORY

Fuzzy Sets – Set-theoretic operations – Member Function Formulation and parameterization – Fuzzy Rules and Fuzzy Reasoning - Extension principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models-Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

UNIT II **9 Hours**

GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION

Genetic Algorithms-Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators – Particle Swarm Optimization- Topologies – Control parameters-Multi Objective Optimization Algorithm.

UNIT III **9 Hours**

ARTIFICIAL NEURAL NETWORK

Artificial neuron, activation function, supervised, unsupervised learning, Single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network– Reinforcement learning.

UNIT IV **9 Hours**

DEEP NEURAL NETWORKS

Convolutional Neural networks- LeNet- AlexNet – GoogLeNet – ResNet - Long Short-Term Memory- Gate Recurrent Unit- Deep Belief Network - Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms

UNIT V **9 Hours**

AI APPLICATIONS

Load forecasting - Fault Identification in transmission lines - Energy management in Micro Grid - Duty ratio optimization in power converters.

Total: 45 Hours

Reference(s)

1. Ethem Alpaydin, Introduction to Machine Learning, Fourth Edition,MIT Press, 2020.
2. Andrew Glassner, Deep Learning: From Basics to Practice , First Edition, The Imaginary Institute, Seattle, 2018.
3. H J Zimmermann, Fuzzy set theory and its application, Second Edition, Allied Publishers, 2014.
4. Xin-She Yang , Nature – Inspired Optimization Algorithms, Second Edition , Elsevier , 2020.
5. Gheisarnejad, Meysam, Hamed Farsizadeh, and Mohammad Hassan Khooban. "A novel nonlinear deep reinforcement learning controller for DC–DC power buck converters." IEEE Transactions on Industrial Electronics 68.8 (2020): 6849-6858.
6. Asbery, Chris, and Yuan Liao. "Fault identification on electrical transmission lines using artificial neural networks." Electric Power Components and Systems 49.13-14 (2022): 1118-1129.

22EE038 BIG DATA ANALYTICS FOR SMART GRID 3 0 0 3

Course Objectives

- To understand the fundamental concepts of big data analytics.
- To understand the fundamentals of various big data analytics techniques
- To apply concept of cloud computing techniques for smart grid.
- To apply the big data analytics for smart grid data management.
- To analyse the smart metering data set in the power system.

Programme Outcomes (POs)

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

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the concepts of big data applications for smart grid.
2. Analyse the big data tools and its analysis techniques.
3. Analyse the benefits of cloud computing in smart grid technology.
4. Analyze the role of big data in smart grid data management systems.
5. Design solutions for smart grid system using big data analytics.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to Big Data Analytics - Fundamental Mathematical Prerequisites, Big Data Era, General Security Challenges - Challenges of conventional systems - Modern data analytic tools. History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System.

UNIT II **9 Hours**

DATA ANALYSIS

Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction. Sampling and large sample tests, chi- square test, theory of estimation, linear and polynomial fitting by the methods, correlation of bivariate frequency distribution.

UNIT III **9 Hours**

CLOUD COMPUTING APPLICATIONS FOR SMART GRID

Cloud computing in smart grid, Cloud computing architecture, Demand Response - Geographical Load-Balancing - Dynamic Pricing - Virtual Power Plant - Advanced Metering Infrastructure - Cloud-Based Security and Privacy.

UNIT IV **9 Hours**

SMART GRID DATA MANAGEMENT AND APPLICATIONS

Pricing and energy forecasting in Demand Response, case study on Energy Forecast, Smart Meter Data Management -PHEVs: Internet of Vehicles - Smart Buildings.

UNIT V **9 Hours**

SMART GRID DESIGN AND DEPLOYMENT

Attack detection, current problem and techniques, Secure Data Learning Scheme, Logical Security Architecture, Smart Metering Data Set Analysis—A Case Study, Security Schemes for AMI Private Networks, Simulation Tools- Worldwide Initiatives - Use of data analytics for renewable energy integration and grid resilience

Total: 45 Hours

Reference(s)

1. Smart Grid Technology: A Cloud Computing and Data Management Approach, S. Misra and S. Bera, Cambridge University Press, 2018, 1st Edition.
2. Smart Grid Communication Infrastructure: Big Data, Cloud Computing and Security, F. Ye, Y. Qian and R.Q. Hu, Wiley IEEE Press, 2018, 1st Edition.
3. Smart Grid: Fundamentals of Design and Analysis, James A. Momoh, Wiley India, 2015, 1st Edition.
4. Big Data and Analytics, Seema Acharya, Subhashini Chellapan,, Wiley, 2015.
5. Big data analytics in future power systems, Ahmed F. Zobaa, Trevor J. Bihl, 1st Edition, CRC press 2018.

22EE039 INDUSTRY 4.0 3 0 0 3

Course Objectives

- To expose the various stages of industrial revolutions.
- To introduce and familiarize the industry 4.0 and its physical structure and interconnectivity.
- To understand the different Automation Systems concepts for various sectors from the Industry 4.0 perspective.
- To outline the cloud computing and cyber security in the robotics industry.
- To understand the concepts VR systems, work and list the applications of VR.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the concept of Industry 4.0 transformation in industries.
2. Analyse the various systems used in a manufacturing plant and their role in an Industry 4.0 world.
3. Apply the concept Understand the smartness in Smart Factories, Smart cities, smart products and smart Services.
4. Analyze the types of Cloud computing and cyber security in a networked industrial System.
5. Analyze the Virtual reality requirements in the industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, how is India preparing for Industry 4.0.

UNIT II **9 Hours**

A CONCEPTUAL FRAMEWORK

Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0, Obstacles and Framework Conditions for Industry 4.0.

UNIT III **9 Hours**

TECHNOLOGY ROADMAP

Proposed Framework for Technology Roadmap, Strategy Phase, New Product and Process Development Phase ,Case Study: Smart Manufacturing, Smart Devices and Products.

UNIT IV **9 Hours**

ADVANCES IN ROBOTICS

Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

UNIT V **9 Hours**

VIRTUAL REALITY

Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, VR Hardware and Software Technology, Industrial Applications of VR.

Total: 45 Hours

Reference(s)

1. Alp Ustundag, Emre Cevikcan, “Industry 4.0: Managing the Digital Transformation”, springer, 2017.
2. Lane Thames, Dirk Schaefe, “Cybersecurity for Industry 4.0: Analysis for Design and Manufacturing”, springer, 2017.
3. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, “Handbook of Industry 4.0 and SMART Systems”, Taylor and Francis,2020.
4. Steven M. LaValle, “Virtual Reality”, Cambridge University Press, 2016.
5. William R Sherman and Jeffrey D Will, Morgan Kaufmann, Alan B Craig, “Developing Virtual Reality Applications: Foundations of Effective Design”, 2009.

22EE040 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To understand the basic components of automotive electronics.
- To illustrate the components of charging system and starter motor for starting system.
- To analyze the different types of ignition system used in automobiles.
- To understand the types of batteries and lighting systems used in automobiles.
- To summarize the various sensors and actuators used in automobiles.

Programme Outcomes (POs)

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply various types of control systems used in automotive electronics.
2. Apply the concept of motor starting system and generator for charging system.
3. Analyze the various ignition triggering devices used in the ignition system.
4. Analyze the types of batteries, testing methods and lights used in automotive applications.
5. Apply the various types of sensors and actuators in automobile applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO AUTOMOTIVE ELECTRONICS

Automobile Systems -Engine- Engine control- Ignition system -Ignition timing- Drive train-Suspension Brakes-Steering system. Control systems- Proportional, Proportional Integral and Proportional Integraldifferential controller - Closed-Loop Limit-Cycle Control, electronic dashboard instruments -On-board diagnostic systems.

UNIT II **10 Hours**

STARTING AND CHARGING SYSTEMS

Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids, Charging system components, Generators and Alternators, types, construction and Characteristics. Voltage and Current Regulation, Cut-out relays and regulators. Charging circuits for D.C. Generator.

UNIT III **9 Hours**

IGNITION SYSTEM

Battery Coil and Magneto-Ignition System, Components, Centrifugal and Vacuum Advance Mechanisms, Spark Plugs, Electronically-Assisted and Full Electronic Ignition System, Non-Contact-type Ignition Triggering devices, Capacitive Discharge Ignition Distributor-less Ignition System.

UNIT IV **9 Hours**

BATTERIES AND LIGHTING SYSTEMS

Principle and construction of Lead Acid Battery, Characteristics of Battery, Battery Rating, Capacity andEfficiency, Various Tests on Battery, Battery-Charging Techniques. Lighting system: insulated and earthreturn system, head light and side light, LED lighting system, head light dazzling and preventive methods.

UNIT V **8 Hours**

SENSORS AND ACTUATORS

Sensors - Oxygen Sensors, Throttle Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Crankshaft Position Sensor, Manifold Absolute Pressure Sensor -Engine Coolant Temperature Sensor, Knock Sensor, Airflow rate sensor. Actuators - Fuel Metering Actuator, Fuel Injector, Ignition Actuator.

Total: 45 Hours

Reference(s)

1. Tom Denton, Automobile Electrical and Electronic Systems, Automotive Technology: Vehicle Maintenance and Repair, 4th Edition, Butterworth-Heinemann, 2011.
2. W. H. Crouse, Automotive Electrical Equipment, McGraw-Hill, 1996.
3. A W Judge, Modern Electrical Equipment for Automobiles, Chapman & Hall, 1992.
4. P. L. Kohli, Automotive Electrical Equipment, First Edition, McGraw-Hill, 2017.
5. Robert Bosch Automotive Hand Book, 9th Edition, Robert Bosch, 2014.

22EE043 PRODUCT DESIGN AND DEVELOPMENT 3 0 0 3

Course Objectives

- Understand the basic concepts of engineering design
- Apply the techniques for collecting customer needs
- Apply decision theory for evaluation methods
- Select the most viable design concepts based on criteria.
- Analyze the user-friendly products

Programme Outcomes (POs)

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

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

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

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

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

PO9: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Evaluate different wiring systems and implement safety measures.
2. Analyze voltage drop and implement effective earthing systems.
3. Evaluate and rectify faults in electrical wiring installations effectively.
4. Analyze various energy conservation techniques applicable to electrical wiring.
5. Analyze various electrical codes and standards.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION OF PRODUCT DEVELOPMENT

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

UNIT II **9 Hours**

CUSTOMER NEEDS

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics- competitive benchmarking- quality function deployment- house of quality-product design specification-case studies

UNIT III **9 Hours**

CREATIVE THINKING

Creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods-TRIZ- axiomatic design.

UNIT IV **9 Hours**

DECISION MAKING

Decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design – product architecture – types of modular architecture –steps in developing product architecture

UNIT V INDUSTRIAL DESIGN **9 Hours**

Human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing.

Total: 45 Hours

Reference(s)

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
2. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
3. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
4. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN 9788177588217
5. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

22EE046 SENSORS AND WEARABLE TECHNOLOGY 3 0 0 3

Course Objectives

- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life.
- To familiarize the characteristics, working principle and application of special purpose transducers.
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Gain the basic idea of measurements, characteristics and the errors associated with measurements.
2. Demonstrate the concept of resistive sensors which can be employed for real life applications.
3. Realize the concept of reactive sensors employed for real life applications.
4. Understand the working principle of special purpose sensors and the need for developing smart sensors.
5. Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals.

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION TO MEASUREMENTS AND SENSORS

Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, Types of measured Quantities, Units and standards, Calibration and errors . General concepts and terminology of Sensor systems, Transducers classification-sensors and actuators, General input-output configurations, Static and dynamic characteristics of measurement system.

UNIT II **9 Hours**

RESISTIVE SENSORS

Resistive sensors- Potentiometers, strain gages (piezo-resistive effect), resistive temperature detectors (RTD), thermistors, magneto-resistors, light dependent resistor (LDR), resistive hygrometers, resistive gas sensors. Wearable applications: Strain sensor for monitoring Physiological signals, body movement.

UNIT III **8 Hours**

REACTIVE SENSORS

Inductive sensors - variable reluctance sensors, Hall effect, Eddy current sensors, Linear variable differential transformers (LVDT), variable transformers, magneto-elastic, magneto-resistive, and magnetostrictive sensors. Capacitive sensors- variable capacitor, differential capacitor. Wearable applications: Body/textile antennas for wireless data transmission.

UNIT IV **10 Hours**

SELF-GENERATING SENSORS

Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Wearable applications: temperature sensitive fabric, electrochemical sensors.

UNIT V **8 Hours**

SCOPE OF WEARABLE DEVICES

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.

Total: 45 Hours

Reference(s)

1. A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai.
2. Er. R.K. Rajput, "Electronic Measurements and Instrumentation", S. Chand & Company Ltd.3rd Edition.
3. Bentley, John P., "Principles of Measurement Systems", 4thedition, Pearson/Prentice Hall,2005.
4. Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier Inc., 2005.
5. Subhas C. Mukhopadhyay, "Wearable Electronics Sensors-For Safe and Healthy Living", Springer International Publishing, 2015.

ONE CREDIT COURSES

22EE0XA INTEGRATED CIRCUITS FOR POWER MANAGEMENT

1 0 0 1

Course Objectives

To provide an overview about the,

- Power architecture design strategies with the foundation of basic principles, key design factors·
- Design, implementation, improvements in the power management due to the advancements in the Integrated circuits.
- Hands-on design experience with a basic calculation tool and an available online circuit simulation tool

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyse the design and applications of integrated circuits (ICs) that are specifically tailored for power management purposes.
2. Apply the knowledge on power management, including voltage regulation, current limiting, power conversion, and energy efficiency.

Articulation Matrix

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

15 hours

Boundary of coverage - Revision of fundamentals - Voltage, current, Power, Efficiency - Types of DC-DC Converters - Switching Regulators and Linear Regulators - Thermal Analysis and Power budget Estimation - Design Using Linear Regulators - Input Parameter Analysis - Output Parameter Analysis - Power dissipation Analysis - Design Calculation - Components Selection and Simulation - Design Using Switching Regulators - Input Parameter Analysis - Output Parameter Analysis - Power dissipation Analysis - Design Calculation - Components Selection and Simulation.

Total: 15 Hours

Reference(s)

1. Robert W. Erickson and Dragan Maksimovic (2001). Fundamentals of Power Electronics.
2. Mona M. Hella, Patrick Mercier (2017). Power Management Integrated Circuits.
3. Arman Vassighi, ManojSachdev(2010).Thermal and Power Management of Integrated Circuits.
4. Emre Salman, Eby G. Friedman (2012).High Performance Integrated Circuit Design

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22EE0XB VISIONARY AUTOMATION

1 0 0 1

Course Objectives

1. To Understand the range of hardware and software offerings provided by National Instruments for data acquisition and vision applications.
2. To Identify various vision components, including cameras, lenses, and lighting systems, and their roles within a vision system using DAQ.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Analyze the key features, capabilities, and specifications of various National Instruments hardware components.
2. Apply LabVIEW programming skills to develop comprehensive applications that seamlessly integrate data acquisition and vision functionalities.

Articulation Matrix

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

Introduction to National Instruments Hardware and Software platforms – Types of Architectures in LabVIEW programming – Integration and Testing of Data Acquisition System – Types and Selection of Vision components – Camera – Lens – Integration and configuration of vision components – Development of Application using DAQ and
Vision modules.

Total : 15 Hours

Reference(s)

1. Jennings, R. and De La Cueva, F., 2020. LabVIEW graphical programming. McGraw-Hill Education.
2. Bitter, R., Mohiuddin, T. and Nawrocki, M., 2017. LabVIEW: Advanced programming techniques. CRC press.
3. RiteshKanjee, 2018, Learn Computer Vision and Image Processing in LabVIEW.
4. Seong-Min, K., Young-Choon, L., & Lee, S.-C. SICE-ICASE , 1508-1512. Wyszecki, G., & Stiles, W. (1982).
5. Color Science: Concepts and Methods Quantitative Data and Formulae. New York: John Wiley & Sons.

Resource Person:

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22EE0XC SOLAR PV SYSTEM DESIGN AND IMPLEMENTATION

1 0 0 1

Course Objectives

- To analyze site feasibility, solar irradiance, shading analysis, and other factors influencing system design.
- To understand and configure solar arrays, select appropriate inverters and batteries, and integrate balance-of-system components for optimal system performance.
- To understand interconnection requirements, grid integration, and the importance of complying with electrical codes to ensure safe and compliant installations.

Programme Outcomes (POs)

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

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply the principles of solar PV system design by assessing site conditions, sizing arrays, selecting appropriate components, and optimizing system layouts for maximum energy production.
2. Analyze common challenges in solar PV system implementation, such as shading issues, inverter failures, and grid interconnection complications, and develop strategies to address them effectively.

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	2	-	-	-	2	-	-	-	-	2	2

Solar energy and its importance, Solar PV System Components, Site Assessment and Design, Solar PV Array Design, Inverter Selection and Sizing, Battery Storage Systems, Electrical Safety and Codes, System Monitoring and Maintenance, Economic Analysis and Financial Considerations, Case Studies and Practical Exercises, Emerging Trends in Solar PV, Environmental and Sustainability Considerations.

Total : 15 Hours

Reference(s)

1. Dunlop, D. W. A, "Solar Photovoltaic System Applications: A Guidebook for Off-Grid Electrification", Springer, Ist Edition, 2019.
2. Roger A. Messenger and Jerry Ventre, "Photovoltaic Systems Engineering", CRC Press, 3rd Edition, 2017
3. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers" Academic Press, 2016 (2nd Edition).
4. Michael Boxwell, "Solar Electric Handbook: Photovoltaic Fundamentals and Applications", Greenstream Publishing. 2nd edition, 2016.

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22EE0XD LOW POWERED INDUSTRIAL EDGE AGENT

1 0 0 1

Course Objectives

- To Understand the software offerings provided by Espressif Systems for data acquisition and various applications in Low Power.
- Identify various supported components/HW, including basic electronic devices.
- Understand how to code for a problem statement in Espressif IDF.

Programme Outcomes (POs)

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply low-power Espressif modules to develop energy-efficient solutions for industrial automation, smart buildings, and IoT applications.
2. Analyze and code for Edge Embedded modules on IDF-SDK.
3. Apply the knowledge to handle logical problem statements in Embedded Programming.

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

Introduction on EspressifDevKit - About Espressif-IDF SDK - Real-Time examples, Usease - discussions - "Hello World" compilation with IDF environment - Interfacing - LED, Switches, Relays, Digital Sensor(s) - Timer, Delays, PWM - Real world Problem solving 1 - Real world Problem solving 2.

Total: 15 hours

Reference(s)

1. https://www.espressif.com/en/products/sdks/esp-idf
2. https://github.com/espressif/esp-IoT-solution

Resource Person

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22EE0XE INDUSTRIAL POWER SUPPLY DESIGN AND IMPLEMENTATION

1 0 0 1

Course Objectives

- To learn the various types of power supply design circuits used in industry.
- To analyze the Power system design and its performance in industrial application.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Evaluate the performance of Power supply system design based on given requirements.
2. Analyze, and learn the applications of integrated circuits (ICs) that are specifically tailored for power management purposes.
3. Apply power management, including voltage regulation, current limiting, power conversion, and energy efficiency in different application.

Articulation Matrix

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

Introduction to Power Management - Architecture of Power supply circuits- Need of Converters/Regulators - Deep-dive of Power Supply Design using WEBENCH Power Designer – Introduction to WEBENCH – Designing Power Circuit with WEBENCH tools – Topologies Used in WEBENCH –Power Management Portfolio – Key Features – Converter design using WEBENCH - System Testing – Basic Project development from given requirements.

Total: 15 hours

Reference(s)

1. https://webench.ti.com/power-designer
2. https://e2e.ti.com/support/tools/sim-hwsystem-design/
3. Mona M. Hella, Patrick Mercier (2022). Power Management Integrated Circuits.
4. Arman Vassighi, Manoj Sachdev(2023).Thermal and Power Management of Integrate Circuits.

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22EE0XF DESIGN OF POWER CONVERTER FOR INDUSTRIAL APPLICATIONS

1 0 0 1

Course Objectives

- To analyze the conceptual design of converter, inverter for AC motor speed control application.
- To analyze the Solar panel performance for pumping application.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Evaluate the performance of converter and its filters design parameters.
2. Evaluate the performance of Inverter design and its gate drivers.
3. Analyze the performance of power supply design using DC-DC converter.

Articulation Matrix

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

Basics of Electronic components – Packages used – Basis of Solar panel and its MPPT algorithm – Rectifier Design – Inverter Design – Selection of Gate Driver for various switching devices – Bootstrap method for High side Gate driver - DC – DC converter design – Voltage, Current and temperature sensing circuit – Speed control techniques for AC and DC Drives – Converter design for DC Drives using SCR.

Total: 15 hours

Reference(s)

1. Muhammad H.Rashid, 'Power Electronics Circuits, Devices & Applications', 4th Edition, Pearson India, 2018.
2. Control Integrated Power System (CIPOS™) IKCM30F60GD – Application Note by Infineon.
3. Gustavo Azevedo "Losses and CMV Evaluation in Transformerless Grid-Connected PV Topologies", IEEE International Symposium on Industrial Electronics (ISlE 2009) Seoul Olympic Parktel, Seoul, Korea July 5-8, 2009.
4. Infineon "2ED020I12-F2 1200 V dual high-side gate driver IC with galvanic isolation, DESAT and short circuit clamping", Datasheet of Dual IGBT Driver IC.

Resource Person

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22EE0XG PCB FABRICATION OF POWER SEMICONDUCTOR DEVICES

1 0 0 1

Course Objectives

- To learn the Schematic Design and connection in PCB fabrication.
- To gain knowledge on PCB Design rules and design constrain.
- To understand PCB design associated in AC Drives.

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply advanced PCB design principles using Altium Designer to generate schematics and footprints for complex electronic circuits.
2. Generate schematic and Footprints of PCB fabrication in Altium Design Software.
3. Evaluate the performance of track for high power design.
4. Analyze the Device datasheet for PCB Design Process.

Articulation Matrix

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

Basics of Electronic components – overview of SMT and Through hole components – Components package - Clearance – Creepage - PCB Constrain - Altium Software Overview - Schematic design - Footprint Generation - BOM - PCB design - Via in Pad - Datasheet study - PCB design of Buck Converter - Inverter Design - Gerber Generation - Drill Drawings.

Total: 15 hours

Reference(s)

1. Best Practices for Using PCB Reference Designs: Website reference - https://resources.altium.com/p/best-practices-using-reference-designs
2. Low-Side Current Sensing Circuit Design -- Application note of ROHM.
3. Wide-Input Range CC/CV Step Down Converter - C3221F -- Datasheet by CDIL.
4. Infineon “2ED020I12-F2 1200 V dual high-side gate driver IC with galvanic isolation, DESAT and short circuit clamping”, Datasheet of Dual IGBT Driver IC.
5. TU0117 - Getting Started with PCB Design - Altium Software

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22EE0XH ADVANCED EMBEDDED SYSTEMS PROGRAMMING

1 0 0 1

Course Objectives

- To learn the Advanced Embedded Systems Programming with C and STM32 Microcontrollers.
- To improve operational effectiveness and product innovation by designing, developing, and troubleshooting embedded systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Develop coding in embedded systems with the help of C programming language.
2. Analyse the software development, interface design, and system architecture for real-time applications.
3. Design solutions for challenging problems like controlling real-time embedded protocols and high-speed data processing.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	3	-	-	2	1	-	-	-	3	3
2	1	2	2	-	3	-	-	2	1	-	-	-	3	3
3	1	2	2	-	3	-	-	2	1	-	-	-	3	3

Introduction to STM32 architecture and families- STM32CubeIDE Installation-Project Creation in STM32CubeIDE-project structure and configurations -Introduction to C programming for microcontrollers- -Simple Programs-functions and modular programming-Work with arrays and pointers in C-I/O operations-GPIO (General Purpose Input/Output) programming-Introduction to Timers and their applications -Use of interrupts to handle timer events- Implement a simple UART communication between two STM32 boards.-Introduce basic debugging techniques using STM32CubeIDE.

Total: 15 hours

Reference(s)

1. Carmine Noviello, “Mastering STM32 by Carmine Noviello”, Leanpub Publication, 2022.
2. Agus Kurniawan, “Getting Started With STM32 Nucleo Development”, Agus Kurni Publications, 2016.
3 Geoffrey Brown, “Discovering the STM32 Microcontroller”, Indiana Unversity Publicatios, 2016.

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22EE0XI REAL TIME PROGRAMMING IN MULTICORE PROCESSOR

1 0 0 1

Course Objectives

- To learn about multi-core processors and their architecture, including parallelism, synchronization, and communication mechanisms.
- To gain hands-on experience that involves designing and implementing real-time applications on multi-core processors..

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply programming languages such as C/C++ for real-time multi-core programming.
2. Analyze the performance of real-time multi-core systems and make informed decisions to improve performance in ESP 32.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	-	3	-	-	2	1	-	-	-	3	3
2	1	2	2	-	3	-	-	2	1	-	-	-	3	3

Introduction to Multicore processor - ESP32 Architecture - Programming ESP32 - Communication Interfaces – Integration of Sensors and Actuators – Power modes in ESP32 – Security Features and IoT application in ESP32. Embedded Programming for ESP32 – GPIO Interfacing – Communication Interface – Setting up WiFi and Bluetooth connection – actuator control – Power Management and IoT implementation.

Total: 20 hours

Reference(s)

1. Phillip A. Laplante, "Real-Time Systems Design and Analysis: Tools for the Practitioner", Wiley Publication, 2012.
2. Sabri Pllana and Fatos Xhafa, "Programming Multicore and Many-core Computing Systems", Wiley Publications, 2017.
3. Agus Kurniawan, "Internet of Things Projects with ESP32", Packt Publishing, 2019.

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22EE0XJ BATTERY ENERGY STORAGE SYSTEMS FOR MICROGRID

1 0 0 1

Course Objectives

- To familiarize with the knowledge of Battery Energy Storage System (BESS) and Microgrids and gain knowledge and skills necessary to design, develop and optimise the BESS and Microgrids from various perspectives.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO7.Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO1. Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.
PSO2. Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Apply battery energy storage system (BESS) integration techniques to optimize energy management, stability and performance in microgrid applications.
2. Apply effective BESS solutions tailored to microgrid requirements.
3. Analyze BESS performance metrics and optimize microgrid energy utilization.
4. Evaluate BESS safety, reliability, and environmental sustainability within microgrid setups.
5. Apply knowledge to enhance microgrid stability, resilience, and renewable energy integration.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	3	3	-	-	-	2	-	-	-	3	2
2	3	3	-	2	2	-	-	-	2	-	-	-	3	2
3	3	3	-	2	2	-	-	-	2	-	-	-	3	2
4	3	3	-	2	2	-	1	-	2	-	-	-	3	2
5	3	3	1	3	3	-	1	-	2	-	-	-	3	2

Introduction to Battery Energy Storage Systems (BESS) - Battery Technology and Selection - Battery management systems (BMS) - Microgrids - Microgrid Design - Microgrid System Modeling in HomerPro - Microgrid Simulation and Analysis - Project Work and Case Studies.

Total: 20 hours

Reference(s)

1. Mohammadreza Daneshvar, Juan C. Vasquez, Josep M. Guerrero, "Battery Energy Storage Systems for Smart Grids", Wiley, 1st Edition, 2021.
2. Patrick L. Vedral, Rupp Carriveau, "Battery Energy Storage Systems for Electric Utilities", Springer, 1st Edition, 2020.
3. Zhaoyang Dong, Reza Arghandeh, Khalid Al-Hosani, "Battery Energy Storage in Power Systems", Springer, 1st Edition, 2019.

Resource Person

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22EE0XK IoT BASED AUTOMATION SYSTEMS FOR IRRIGATION

1 0 0 1

Course Objectives

- To familiarize students with IoT principles in irrigation, enabling them to design and implement automated systems and learn data analysis techniques for optimizing water usage, promoting sustainable agricultural practices.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1: Design, analyze, and evaluate the performance of real-world problems in the field of Electrical and Electronics using contemporary tools.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Design IoT-based irrigation systems for efficient water management and conservation.
2. Implement automation solutions to optimize resource usage in agricultural settings.
3. Analyze sensor data to monitor soil moisture levels and weather conditions.
4. Enhance crop yields and reduce water waste through smart irrigation techniques.
5. Develop sustainable farming practices using IoT technologies for irrigation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	3	3	-	-	-	2	-	-	-	3	2
2	3	3	-	2	2	-	-	-	2	-	-	-	3	2
3	3	3	-	2	2	-	-	-	2	-	-	-	3	2
4	3	3	-	2	2	-	-	-	2	-	-	-	3	2
5	3	3	1	3	3	-	-	-	2	-	-	-	3	2

IoT Fundamentals - Advanced Sensor Technology - Data Acquisition Methods - Wireless Communication Protocols - Cloud Computing for Agriculture - Artificial Intelligence Applications - Machine Learning Algorithms - Predictive Analytics in Agriculture - Smart Irrigation Systems - Precision Agriculture Techniques - Remote Sensing Technologies - IoT-Enabled Crop Monitoring - Energy-Efficient Irrigation Practices - IoT Security and Privacy.

Total: 20 hours

Reference(s)

1. Peter R. Rony, Khaled M. Elleithy, "Internet of Things: Principles and Paradigms", CRC Press, 1st Edition, 2016.
2. Chandra S. Mukherjee, Hemanth J. Jois, " Smart Agriculture: IoT Based Greenhouse Monitoring System", Springer, 1st Edition, 2020.
3. Rajkumar Buyya, Amir Vahid Dastjerdi, Siddhartha Choudhury, "Internet of Things: Principles and Paradigms", Elsevier, 2nd Edition, 2020.

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OPEN ELECTIVE

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	1
2	1	2	3	-	3	-	-	-	-	-	-	-	-	1
3	1	2	2	-	3	-	-	-	-	-	-	-	-	1
4	1	2	3	-	3	-	-	-	-	-	-	-	-	1
5	1	2	3	-	3	-	-	-	-	-	-	-	-	1

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.

10 Hours
UNIT V
TEMPLATES AND EXCEPTION HANDLING
Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall, 2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

22OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	1
2	2	3	2	-	2	-	-	-	-	-	-	-	-	1
3	3	3	3	-	3	-	-	-	-	-	-	-	-	1
4	2	2	2	-	2	-	-	-	-	-	-	-	-	1
5	2	2	2	-	2	-	-	-	-	-	-	-	-	1

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.

22OCS03 KNOWLEDGE DISCOVERY IN DATABASES 3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	-	-	1
3	2	2	2	-	-	-	-	-	-	-	-	-	-	1
4	3	2	2	2	-	-	-	-	-	-	-	-	-	1
5	2	2	2	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components-Building a Data warehouse –Data Warehouse and DBMS-Metadata-Multidimensional data model- Data Extraction, Cleanup and Transformation Tools-Reporting, Query tools and Applications-OLAP vs OLTP- OLAP operations- Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **9 Hours**

INTRODUCTION TO DATA MINING

Introduction-Stepsinknowledgediscoveryfromdatabasesprocess-ArchitectureofaTypicalData MiningSystems-DataMiningFunctionalities-ClassificationofDataMiningSystems-Dataminingon differentkindsofdata-Differentkindsofpattern-TaskPrimitives-Integration ofa Data MiningSystem with a Data Warehouse- Major issues in Data mining.

UNIT III **9 Hours**

ASSOCIATION RULE MINING

MarketBasketAnalysis-FrequentItemSetMiningmethods:Apriorialgorithm-GeneratingAssociation 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 base dagglomerative and divisible clustering, BIRCH–Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **9 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 Kamberand Jian Pai,Data Mining:Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Bersonand Stephen J Smith, Data Warehousing, Data Mining, and OLAP, TataMcgraw- Hill,1997.
3 David Hand, Heikki Manila, PadhraicSymth, PrinciplesofDataMining, MITPress, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

22OCS04 E-LEARNING TECHNIQUES **3 0 0 3**

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Program Outcomes (POs)

PO1Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	-	-	1
3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	-	-	-	-	-	-	-	-	-	1
5	2	2	2	-	-	-	-	-	-	-	-	-	-	1

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 -VirtualLibrary.

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.

3 0 0 3

22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS

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

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	1
3	2	3	-	3	3	-	-	-	-	-	-	-	-	1
4	2	2	2	3	2	-	-	-	-	-	-	-	-	1
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

22OEC03 PRINCIPLES OF COMMUNICATION SYSTEMS 3 0 0 3

Course Objectives

- To study the various analog and digital modulation techniques
- To study the various digital communication techniques
- To enumerate the idea of spread spectrum modulation
- To study the design concepts of satellite and optical communication

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

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	PSO1	PSO2
1	3	2	2	-	-	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	2	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	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-Optical Communication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

FOR FURTHER READING

RADAR Communication: Basic Radar, The simple form of the Radar Equation, Radar Block Diagram, Radar Frequencies, Applications of Radar.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub,D L Schilling,G Saha ,Principles of Communication,3/e,2007.
4. B.P.Lathi,Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS 3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

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	PSO1	PSO2
	1	2	1	1	-	-	-	-	-	-	-	-	2	-
2	1	2	2	3	-	-	-	-	-	-	-	-	2	-
3	1	1	2	3	-	-	-	-	-	-	-	-	2	-
4	1	1	3	-	-	-	-	-	-	-	-	-	2	-
5	1	2	3	3	-	-	-	-	-	-	-	-	2	-

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

22OEI02 SENSOR TECHNOLOGY 3 0 0 3

Course Objectives

- To impart knowledge about various sensors in multidisciplinary engineering domain.
- To familiarize students with different applications and its material handling technology
- To understand the concept of sensing circuits and its static and dynamic characteristics

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Conclude the static and dynamic characteristics of measuring instruments.
2. Compare the characteristics and working principles of Resistance, Inductance and Capacitance type sensors.
3. Construct the interfacing and signal conditioning circuit for measurement system using different types of sensor.
4. Analyze and select the suitable sensor for different industrial applications.
5. Combine the modern technologies and smart materials to design various sensors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	1	2	1	1	-	-	-	-	-	-	-	-	-	1
2	1	2	2	3	-	-	-	-	-	-	-	-	-	1
3	1	1	2	3	-	-	-	-	-	-	-	-	-	1
4	1	1	3	-	-	-	-	-	-	-	-	-	-	1
5	1	2	3	3	-	-	-	-	-	-	-	-	-	1

UNIT I 8 Hours

SENSORS FUNDAMENTALS AND CHARACTERISTICS

Sensors: Principles of Sensing - Sensor Classification and terminology- Units of Measurements - Measurands- Sensor Characteristics: Static and Dynamic.

UNIT II 9 Hours

PHYSICAL PRINCIPLES OF SENSING

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

22OEI03 FUNDAMENTALS OF VIRTUAL INSTRUMENTATION

3 0 0 3

Course Objectives

- Understand the basic components of Virtual Instrumentation system.
- Learn the developing VIs based on Lab VIEW software.
- To learn to develop applications based on Virtual Instrumentation system.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10 Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Outline the concepts of traditional instruments and virtual instruments.
2. Conclude the overview of modular programming and the structuring concepts in VI programming.
3. Attribute the procedure to install DAQ in various OS and its interfacing methods.
4. Implement the VI toolsets for specific applications.
5. Generate the applications using Virtual Instrumentation software.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	2	2	-	-	-	-	2	2	2	-	-
3	2	2	2	1	-	-	-	-	-	-	-	-	-	-
4	3	3	3	1	2	-	-	-	-	1	2	2	-	-
5	3	2	2	1	2	-	-	-	-	1	2	2	-	-

UNIT I **9 Hours**

INTRODUCTION

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II **9 Hours**

VI PROGRAMMING TECHNIQUES

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III **9 Hours**

DATA ACQUISITION

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT IV **9 Hours**

VI TOOLSETS

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipment like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V **9 Hours**

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total: 45 Hours

Reference(s)

1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement,

22OEI04 OPTOELECTRONICS AND LASER INSTRUMENTATION 3 0 0 3

Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication
- To be recognized with industrial applications of fibers
- To understand the fundamental concepts about lasers
- To identify and describe various fiber optic imaging and optoelectronic sensor applications

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

Course Outcomes (COs)

1. Attribute the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Conclude the fundamentals of laser, types of laser and its working.
4. Outline the applications of laser for industrial applications.
5. Differentiate the use of laser instruments for various medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-	1
2	3	2	1	2	-	-	-	-	-	-	-	-	-	1
3	3	2	1	-	-	-	-	-	-	-	-	-	-	1
4	3	2	2	2	-	-	-	-	-	-	-	-	-	1
5	3	2	2	2	-	-	-	-	-	-	-	-	-	1

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III **9 Hours**

LASER FUNDAMENTALS

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials - removal and vaporization - calculation of power requirements of laser for material processing.

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

Total: 45 Hours

Reference(s)

4. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India,2010.
5. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
6. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
7. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
8. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
9. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	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**

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

22OME02INDUSTRIAL 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

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11 Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	1
2	3	3	1	-	2	-	-	-	-	-	2	-	-	1
3	1	3	3	-	2	-	-	-	-	-	-	-	-	1
4	2	3	1	-	2	-	-	-	-	-	-	-	-	1
5	2	3	1	-	2	-	-	-	-	-	-	-	-	1

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

22OME03MAINTENANCE 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.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.

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	-	-	-	-	-	-	-	-	-	-	-	1
2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	2	2	1	-	-	-	-	-	-	1
4	1	2	1	-	2	2	2	-	-	-	-	-	-	-
5	2	2	2	-	1	1	1	-	-	-	-	-	-	1

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING **3 0 0 3**

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	2	1		1	-	-	-	-	-	-
2	-	-	-	-	1			3	-	-	-	-	-	-
3	2	-	-	-	-	-	-	-		-	-	3	-	-
4	2	3	-	-	-	-	-	-	2	-	-	-	-	-
5	-	-	-	-	2	-	-	-	-	3	-	-	-	-

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop - Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high-rise buildings - Working at heights-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces.

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

22OBT01 BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more eco-friendly options.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply the bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio-refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	-	-	-	3	-	-	-	-	-	-	-
2	2	1	-	3	-	-	1	-	-	-	-	-	-	-
3	1	2	-	2	-	2	3	-	-	-	-	-	-	-
4	2	3	-	-	-	2	3	-	-	-	-	-	-	-
5	1	2	3	3	-		1	-	-	-	-	-	-	-

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feedstocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high-speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, and purification - wet and dry milling processes, saccharification- chemical and enzymatic. Production of bio methane and biohydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008.
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007.

22OFD01TRADITIONAL FOODS 3 0 0 3

Course Objectives

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3	2	1	1	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	2	-	-	-	-	-	-
5	-	-	-	-	-	-	-	2	-	-	-	-	-	-

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products: -Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan, andBanerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

3 0 0 3

22OFD02 FOOD LAWS AND REGULATIONS

Course Objectives

- To introduce the concept of food hygiene, importance of safe food and laws governing it
- To learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- To understand food inspection procedures employed in maintaining food quality

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	-	-	-	-	-	-	-	-	-	-	-
2		1	-	-	-	1	2	1	-	-	-	-	-	-
3		1	-	-	-	-	-	-	-	-	-	-	-	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claim.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES

3 0 0 3

Course Objectives

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1	-	-	1	-	-	-	-	-	-	-
2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	-
4	1		1	-	-	-	-	-	-	-	-	-	-	-
5	2	1	1	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S. Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- To understand the application of scientific principles in the processing technologies specific to the materials
- To understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- To develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO4 Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	2	-	2	-	-	-	-	-	-	-	-
2	1	2	-	2	-	1	-	-	-	-	-	-	-	-
3	2	2	-	1	-	2	-	-	-	-	-	-	-	-
4	2	3	-	2	-	2	-	-	-	-	-	-	-	-
5	2	2	-	2	-	3	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products -

Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L. Kent and A.D. Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman), Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition, CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

3 0 0 3

22OFT01 FASHION CRAFTSMANSHIP

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.

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9 Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3	-	-	-	2	-	2	2	-	2	-	-
2	3	2	3	-	-	-	1	-	2	3	-	2	-	-
3	3	2	3	-	-	-	2	-	2	3	-	2	-	-
4	3	2	3	-	-	-	2	-	2	3	-	2	-	-
5	3	2	3	-	-	-	2	-	2	3	-	2	-	-

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

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

22OFT02INTERIOR 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

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3	-	-	1	-		-	-	-	-	-	-
2	3	2	3	-	2	3	-	2	-	-	-	-	-	-
3	3	3	3	-	2	2	-	2	-	-	-	-	-	-
4	3	3	3	-	2	3	-	2	-	-	-	-	-	-
5	3	2	-	-	2	-	-	3	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2	-	-	-	-	1	-	-	-	-	-	-
2	2	3	2	-	-	-	-	-	2	-	-	-	-	-
3	2	3	2	-	3	-	-	-	-	-	-	-	-	-
4	2	2	2	-	-	-	-	-	2	-	-	-	-	-
5	2	2	2	-	-	-	-	-	2	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown, Embroidered& Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OPH01 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the origin of nanomaterials from ancient applications to modern nanotechnology
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Analyze the magnetic properties of nanomaterials and their applications in data storage and spintronics
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	1	-	-	-	-	-	-	1	-	-
2	3	2	2	1	1	-	-	-	-	-	-	1	-	-
3	3	2	2	1	1	-	-	-	-	-	-	1	-	-
4	3	2	2	1	1	-	-	-	-	-	-	1	-	-
5	3	2	2	1	1	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

9 Hours

UNIT II

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes-structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics

Total: 45 Hours

Reference(s)

1. W A Goddard and D W Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P Poole, Jr and Frank J Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W Kelsall, Ian W Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006.
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

22OPH03 APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the role of energy levels and excitation processes in laser action
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	1	-	-	-	-	-	-	-	1	-	-
2	3	2	2	1	-	-	-	-	-	-	-	1	-	-
3	3	2	2	1	-	-	-	-	-	-	-	1	-	-
4	3	2	2	1	-	-	-	-	-	-	-	1	-	-
5	3	2	2	1	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd: YAG laser) - semiconductor laser (homojunction laser).

UNIT II **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

22OPH04 BIOPHOTONICS 3 0 0 3

Course Objective:

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4 Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Analyze the fundamental laws of optics and their role in light interaction with biological cells and tissues
2. Apply the principles of light interaction with biological tissues to enhance imaging resolution and contrast
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	2	2	1	-	-	-	-	-	-	-	-	-
2	2	3	2	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	1	-	-	-	-	-	-	-	-	-
4	4	3	2	2	1	-	-	-	-	-	-	-	-	-
5	5	3	2	2	1	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
INTRODUCTION TO BIOPHOTONICS
Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**
PHOTOBIOLOGY
Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**
BIONANO PHOTONICS
Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**
TISSUE ENGINEERING WITH LIGHT
Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**
BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS
An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supra molecules
- To summarize the soft matter properties of structures and components of life

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering science
PSO2: Apply knowledge skills and attitude to conduct experiments and interpret data to solve complex engineering problems in the power systems network, power electronics, electric drives and develop control strategies by considering economic and environmental constraints.s.

Course Outcomes (COs)

1. Analyze the structural and mechanical differences between soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Analyz**e** the optical and electro-optical properties of liquid crystals used in display technologies
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	-	-	-	-	-	-	-	-	-	-	-	1
3	2	2	-	-	-	-	-	-	-	-	-	-	-	1
4	2	2	-	-	-	-	-	-	-	-	-	-	-	1
5	2	2	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids. Physical and chemical gels-classical theory of gelation-elasticity of gels.

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

Total: 45 Hours

Reference(s)

1. Richard A L Jones, Soft Condensed Matter, Oxford University Press, UK, 2002.
2. Masao Doi, Soft Matter Physics, Oxford University Press, UK, 2013.
3. Ian W Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007.
4. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and Oleg D Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING

3 0 0 3

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Apply fundamental principles of corrosion science to calculate corrosion rates, analyze metal degradation and interpret Pourbaix diagrams to predict corrosion behavior in various industrial environments.
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Analyze the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Analyze the rate of corrosion on metals using electrochemical methods of testing
5. Analyze the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-
3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, Create Space Independent Publishing Platform, 1st Edition, 2016.
2. E. McCafferty, Introduction to Corrosion Science, Springer, 1st Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2nd Edition, 2008.
5. David E.J. Talbot and James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press, 2nd Edition, 2007.

22OCH02 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Apply knowledge of polymerization mechanisms to predict the formation of different polymer products under various reaction conditions and catalysts
2. Apply suitable polymerization techniques to synthesize the high quality polymers
3. Apply the structural, thermal, and mechanical properties of polymers for different industrial applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
4	1	1	2	-	-	-	-	-	-	-	-	-	-	-
5	1	3	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene - butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame-retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

22OMA01 GRAPH THEORY AND COMBINATORICS 3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory-based computing and network security studies in Computer Science.

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics and Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A, A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Program Outcomes (POs)

PO9Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	-	3	-	-	-
2	-	-	-	-	-	-	-	-	2	-	2	-	-	-
3	-	-	-	-	-	-	-	-	2	-	2	-	-	-
4	-	-	-	-	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	-	-	-	-	2	-	2	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective Communication-Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Program Outcomes (POs)

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	1	2	-	2	-	-	-	-	-
2	-	-	-	-	-	1	2	-	2	-	-	-	-	-
3	-	-	-	-	-	1	2	-	2	-	-	-	-	-
4	-	-	-	-	-	1	2	-	2	-	-	-	-	-
5	-	-	-	-	-	1	2	-	2	-	-	-	-	-

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Program Outcomes (POs)

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	1	2	-	2	-	-	-	-	-
2	-	-	-	-	-	1	2	-	2	-	-	-	-	-
3	-	-	-	-	-	1	2	-	2	-	-	-	-	-
4	-	-	-	-	-	1	2	-	2	-	-	-	-	-
5	-	-	-	-	-	1	2	-	2	-	-	-	-	-

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04NATION 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

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO3Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Understand 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/

22OAM01 COMPUTER VISION IN HEALTHCARE APPLICATION

3 0 0 3

Course Objectives

- Understand the algorithms and techniques used in image formation.
- Implement the motion computation and 3D vision to generate 3-dimensional images of an object.
- Develop computer vision tools to assist surgeons during procedures, providing real-time feedback and guidance.

Program Outcomes (POs)

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Interpret the image processing techniques for computer vision.
2. Implement the image pre-processing techniques.
3. Demonstrate 3D vision and motion related techniques.
4. Computer Vision for physical rehabilitation and training
5. Analysis of Medical Image for Predictive Analytics and Therapy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	1	-	-	-	-	-	-	-	-	-	-	-
2	2	3	2	-	3	-	-	-	-	-	-	-	-	-
3	2	2	2	-	2	-	-	-	-	-	-	-	-	-
4	2	3	3	-	3	-	-	-	-	-	-	-	-	-
5	2	3	3	2	3	-	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

COMPUTER VISION FOUNDATIONS

History of Computer Vision – Basics of Image Processing, Machine Learning – InformationRetrieval – Neuroscience – Robotics – Speech – Cognitive Sciences –Algorithms, Systemsand Theory .Image Processing - Colour - Linear Algebra Primer - Pixels and Filters – EdgeDetection - Features and Fitting - Feature Descriptors - Image Resizing - Segmentation - Semantic Segmentation - Clustering - Object recognition - Dimensionality Reduction - Face Identification - Visual Bag of Words - Object Detection from Deformable Parts - Semantic Hierarchies and Fine Grained Recognition - Motion - Tracking - Deep Learning

UNIT II **10 Hours**

IMAGE FORMATION AND IMAGE PRE-PROCESSING

Geometric primitives and transformations – Photometric image formation – The digitalcamera – Point operators – Linear Filtering – More neighbourhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization. Feature detection and matching – Segmentation – Edge detection - 2D and 3D feature based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation – Two-Frame Structure from motion – Factorization – Bundle adjustment – Constrained Structure and Motion – Dense motion estimation.

UNIT III **7 Hours**

3D VISION

Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition –Object Detection – Space, Instance and Category Recognition – Recognition Databases and test sets.

UNIT IV **9 Hours**

COMPUTER VISION FOR ASSISTING HEALTHCARE APPLICATIONS

Computer Vision to see - Computer Vision for Cognition - Computer Vision for physicalrehabilitation and training - Computer Vision for CAD systems in surgery - Computer Vision for human-machine interaction - Computer Vision for Ambient Assisted Living - Egocentric (first person) vision.

UNIT V **9 Hours**

HEALTH CARE APPLICATIONS AND CONTEMPORARY ISSUES

Analysis of Medical Image - Computer Vision for Predictive Analytics and Therapy - Fundamental Algorithms for Medical Images - Machine Learning Algorithms for Medical Images – Deep learning approaches for healthcare applications - Contemporary issues.

Total: 45 Hours

Reference(s)

1. Ranjay Krishna, "Computer Vision: Foundations and Applications", Stand ford University, December 2017.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011.
3. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press,2012.
4. Forsyth D A and Ponce J, "Computer Vision: A Modern Approach", Prentice Hall2003.
5. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
6. Forsyth D A and Ponce J, "Computer Vision: A Modern Approach", Prentice Hall2003.

22OAM02 NEURAL NETWORKS 3 0 0 3

Course Objectives

• To understand the major concepts in deep neural networks.
• To apply Convolutional Neural Network architectures for any real-life applications.
• To analyse the key computations underlying deep learning to build and train deep neural networks for various tasks.

Program Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or
processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply Convolution Neural Network for any suitable applications.
2. Analyze the various classifiers of Single-layer perceptron.
3. Apply Convolutional Neural Networks and its variants for any suitable applications.
4. Analyze the Single-layer Feedback Networks with its mathematical foundation.
5. Analyze the various categories of associative memory with its case studies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	-	1	-	-	-	-	-	-	-	-	-
2	2	2	3	-	3	-	-	-	-	-	-	-	-	-
3	1	3	3	-	3	-	-	-	-	-	-	-	-	-
4	2	2	2	-	3	-	-	-	-	-	-	-	-	-
5	2	2	1	-	3	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
INTRODUCTION
Fundamental concepts and Model: Models of artificial Neural Networks, Neural processing,Learning and Adaptation, Neural network Learning rules- Hebbianrule, Perceptron rule, Delta rule.

UNIT II **9 Hours**
SINGLE LAYER PERCEPTRON MODEL
Single-layer perceptron classifiers: Classification model, Features and decision regions,Discriminant functions, Linear machine and Minimum distance classification, Non- parametric training concept, Training and Classification using the Discrete perceptron: algorithm and example, Single layer continuous Perceptron networks fo r linearly separable classifications.

UNIT III **9 Hours**

MULTI LAYER FEED FORWARD NETWORKS

Multilayer feed forward Networks: Linearly separable Pattern classification, Delta learningrule for Multiperceptron model, Generalized Delta learning rule, Feed forward recall and error back propagation training.

UNIT IV **9Hours**

SINGLE LAYER FEEDBACK NETWORKS

Single-layer Feedback Networks: Basic concepts of dynamic systems, Mathematicalfoundations of Discrete-time Hopfield Networks, Mathematical foundations of Gradient typeHopfield networks, Associative memories: Basic concepts, Linear Associator.

UNIT V **9Hours**

ASSOCIATIVE MEMORY

Bidirectional associative memory - associative memory for spatio-temporal patterns – Casestudy: Implementation of NN in anysimulator. Self-Learning: Bidirectional Associative memory.

Total: 45Hours

Reference(s)

1. E. A.E and S. J.E, "Introduction to Evolutionary Computing | The on-line accompaniment to the book Introduction to Evolutionary Computing", Evolutionary computation.org, 2015.
2. F. Lobo, "Evolutionary Computation 2018/2019", Fernandolobo.info, 2018.
3. "EC lab Tools", Cs.gmu.edu, 2008.
4. "Kanpur Genetic Algorithms Laboratory", Iitk.ac.in, 2008.
5. "Course webpage Evolutionary Algorithms", Liacs.leidenuniv.nl, 2017.

22OAI01 FUNDAMENTALS OF DATA SCIENCE

3 0 0 3

Course Objectives

- To learn the basics of data science and statistical inference.
- To understand the concept of data pre-processing.
- Continuous Internal Assessment 40
- Semester End Examinations 60
- To visualize the processed data using visualization techniques.
-

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2.Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.Design/Development of Solutions: Design solutions for complex engineering problems anddesign system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Interpret the basics of data science and exploratory data analysis.
2. Represent the useful information using mathematical skills.
3. Demonstrate the usage of statistical inference and regression models.
4. Perform various data operations for cleaning and grouping of data.
5. Implement the visualization of data using visualization tools..

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	3	3	3	3	3	-	-	-	-	-	-	-	-	-
3	3	3	3	3	3	-	-	-	-	-	-	-	-	-
4	3	3	3	3	3	-	-	-	-	-	-	-	-	-
5	3	3	3	3	3	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleaning, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.

UNIT II **9 Hours**

DESCRIPTIVE STATISTICS I

Frequency distributions – Outliers – relative frequency distributions – cumulative frequency distributions – frequency distributions for nominal data – interpreting distributions – graphs – averages – mode – median – mean – averages for qualitative and ranked data – describing variability– range – variance – standard deviation – degrees of freedom – interquartile range.

UNIT III **9 Hours**

DESCRIPTIVE STATISTICS II

Normal distributions – z scores – normal curve problems – finding proportions – finding scores – more about z scores – correlation – correlation coefficient for quantitative data – computational formula for correlation coefficient – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2.

UNIT IV **9 Hours**

PYTHON FOR DATA HANDLING

Basics of Numpy arrays – aggregations – computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – hierarchical indexing – combining datasets – aggregation and grouping.

UNIT V **9 Hours**

DATA VISUALIZATION

Types of data visualization: Exploratory, Explanatory, visualization with matplotlib – line plots – scatter plots – visualizing errors – density and contour plots – histograms, binnings, and density – three-dimensional plotting– geographic data – data analysis using statmodels and seaborn – graph plotting using Plotly - Visualization Tools: Tableau

Total: 45 Hours

Reference(s)

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.
4. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green TeaPress, 2014.

22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES

3 0 0 3

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations.

Program Outcomes (POs)

PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO8 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2	1	-	-	-	1	-	-	-	2	-	-
2	-	2	2	2	-	-	-	1	-	-	-	2	-	-
3	-	3	2	2	-	-	-	1	-	-	-	2	-	-
4	-	2	2	2	-	-	-	1	-	-	-	2	-	-
5	-	3	2	2	-	-	-	1	-	-	-	2	-	-

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT V **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Sources and scenarios of radiation incidents – guidance for protection of emergency responders -Occupational health surveillance of persons occupationally exposed to radiation in emergencies

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety andHealth; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition, Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT

0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
5	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency

procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligationsSwitch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical
Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett,"Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand with Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance'‘, Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006

22OBM03 HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

Course Outcomes (COs)

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
4	-	2	-	-	-	-	-	-	-	-	-	-	-	-
5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I 9 Hours

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II 9 Hours

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery: Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III 9 Hours

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**

INSTRUMENTATION SYSTEMS

Optical sensors, Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

UNIT V **9 Hours**

APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3 rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4 th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

22OAG01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation
- To acquire knowledge about water harvesting techniques and their implementation
- To practice the design aspects of sustainable rainwater harvesting solutions for communities

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the sources, availability and challenges in water resources management.
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Evaluate various rainwater harvesting methods for groundwater recharging

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	-	-	-	-	3	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
3	1	1	3	-	-	-	2	-	-	-	-	-	-	-
4	1	2	3	-	-	-	2	-	-	-	-	-	-	-
5	1	1	3	-	-	-	2	-	-	-	-	-	-	-

UNIT I **9 Hours**

WATER RESOURCES

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

UNIT II **9 Hours**

WATER CONSERVATION CHALLENGES

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**

SURFACE RUNOFF HARVESTING

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

UNIT IV **9 Hours**

FLOOD WATER HARVESTING

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**

GROUNDWATER HARVESTING

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990.

22OCB01 INTERNATIONAL BUSINESS MANAGEMENT **3 0 0 3**

Course Objectives

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Demonstrate the role and importance of digital marketing in today's rapidly changing business environment.
2. Discover the techniques to help organizations to utilize social media for digital marketing.
3. Analyze the key elements and campaign effectiveness of E-Mail marketing and mobile marketing.
4. Evaluate the effectiveness of a digital marketing campaign using Google Analytics.
5. Apply advanced practical skills to plan, predict and manage digital marketing campaign

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	2	-	2	-	-	-	-	-
2	3	-	-	-	-	-	3	-	2	-	-	-	-	-
3	3	-	-	-	-	-	3	-	2	-	-	-	-	-
4	3	-	-	-	-	-	2	-	2	-	-	-	-	-
5	3	-	-	-	-	-	2	-	2	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory.

UNIT II **9 Hours**

GLOBALIZATION

Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

UNIT III **9 Hours**

INTERNATIONAL BUSINESS STRATEGIES

Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy.

UNIT IV **9 Hours**

FOREIGN EXCHANGE

Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange.

UNIT V **9 Hours**

EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS

Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory.

Total: 45 Hours

Reference(s)

1. John D Daniels, Lee H.Radebaugh, and Sullivan, "International Business", New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, "International Business", New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, "International Business", New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, "International Business", New Delhi: Pearson Education, 2020.
5. K.Aswathappa, "International Business", New Delhi: Tata McGraw Hill, 2020.

22OCE02 COST MANAGEMENT OF ENGINEERING PROJECTS 3 0 0 3

Course Objectives

- To introduce fundamental quantitative techniques, including linear programming, PERT/CPM, and optimization models, for effective cost management.
- To develop analytical skills for solving transportation and assignment problems to enhance resource allocation and cost efficiency.
- To apply learning curve theory in project planning and cost estimation to improve productivity and financial forecasting.
- To enable the use of quantitative decision-making tools for optimizing project scheduling, budgeting, and overall cost control.

Programme Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO6 Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PSO1 Graduates will be able to demonstrate technical skills with inter-disciplinary approach for executing Infrastructural projects ensuring safety, cost-effectiveness and sustainability.

Course Outcomes (COs)

1. Analyze the cost concepts to support decision-making and operational control through a structured cost database.
2. Analyze stakeholder roles to optimize project performance and mitigate cost overruns.
3. Analyze project execution and cost control techniques to support strategic decision-making and optimize project financial performance.
4. Evaluate costing strategies and budgetary control techniques in the service sector.
5. Apply quantitative techniques to optimize cost management and decision-making in projects.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	-	-	-	2	-	-	-	-	1	-	-	-
2	1	2	2	-	-	2	-	-	-	-	-	-	-	1
3	1	2	-	-	-	-	-	-	-	-	2	-	-	1
4	1	2	1	-	--	1	-	-	-	-	2	-	-	1
5	1	2	-	-	-	1	-	-	-	-	2	-	-	1

UNIT I **9 Hours**

INTRODUCTION TO COSTING CONCEPTS

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT 2 **9 Hours**

INTRODUCTION TO PROJECT MANAGEMENT

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT 3 **9 Hours**

PROJECT EXECUTION AND COSTING CONCEPTS

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle costing.

UNIT 4 **9 Hours**

COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT 5 **9 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost

References:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.