B.E. (Electronics and Communication Engineering)

2022 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

Stay Ahead

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

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VISION OF THE DEPARTMENT

To foster academic excellence in Electronics and Communication Engineering education and research and turn out students into competent professionals to serve society.

MISSION OF THE DEPARTMENT

- To establish a unique learning environment and to enable the students to face the challenges in Electronics and Communication Engineering.
- To provide a framework for professional career, higher education, and research activities.
- To impart ethical and value-based education by promoting activities addressing the social needs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Design and develop electronic circuits and systems, based on the existing as well as emerging technologies.

II. Pursue higher education, research, and continue to learn in their profession.

III. Become a successful professional engineer in Electronics/Communication/allied fields.

PROGRAMME OUTCOMES (POs)

1. **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
3. **Design/ Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.
4. **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.
5. **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
6. **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.
7. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
8. **Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective

presentations considering cultural, language, and learning differences.

10. **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.
2. Able to solve the complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive at appropriate solutions.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcomes(s)											
	1	2	3	4	5	6	7	8	9	10	11	12
I			X	X	X	X	X				X	
II	X	X	X	X	X	X		X	X	X	X	X

DEPARTMENT OF ELECTRONICS AND COMMUNICATION 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
22EC108$	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
							CA	ES	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 ACTIVITIE	-	-	-	NC	-	100	0	100	HSS
Total		**15**	**1**	**10**	**21**	**26**	**-**	**-**	**-**	**-**

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

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC301	PROBABILITY, STATISTICS AND RANDOM PROCESS*	3	1	0	4	3	40	60	100	BS
22EC302	CIRCUIT ANALYSIS	3	1	0	4	4	40	60	100	ES
22EC303	DIGITAL LOGIC CIRCUIT DESIGN	3	0	2	4	5	50	50	100	PC
22EC304	ANALOG ELECTRONICS AND INTEGRATED CIRCUITS	3	0	2	4	5	50	50	100	PC
22EC305	DATA STRUCTURES AND ALGORITHMS	2	0	2	3	4	50	50	100	PC
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	40	100	EEC
Total		**16**	**2**	**8**	**22**	**25**	**-**	**-**	**-**	**-**

IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC401	SIGNALS AND SYSTEMS	3	1	0	4	4	40	60	100	BS
22EC402	ANALOG COMMUNICATION	3	0	2	4	5	50	50	100	PC
22EC403	ELECTROMAGNETIC FIELDS AND WAVEGUIDES	3	1	0	4	4	40	60	100	BS
22EC404	CMOS DIGITAL INTEGRATED CIRCUITS	3	0	2	4	5	50	50	100	PC
22EC405	EMBEDDED SYSTEMS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	NC	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	60	40	100	HSS
22HS010$	SOCIALLY RELEVANT PROJECT	-	-	-	NC	-	100	0	100	HSS
Total		**20**	**2**	**8**	**24**	**30**	**-**	**-**	**-**	**-**

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

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

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC501	DIGITAL COMMUNICATION	3	0	2	4	5	50	50	100	PC
22EC502	DIGITAL SIGNAL PROCESSING	3	0	2	4	5	50	50	100	PC
22EC503	TRANSMISSION LINES AND ANTENNAS	3	0	2	4	5	50	50	100	PC
22EC504	INTERNET OF THINGS AND ITS APPLICATIONS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	OE
22EC507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
Total		**18**	**0**	**10**	**23**	**28**	**-**	**-**	**-**	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC601	COMPUTER NETWORKS AND PROTOCOLS	3	0	0	3	3	40	60	100	PC
22EC602	DIGITAL SYSTEM DESIGN WITH FPGA	3	0	2	4	5	50	50	100	PC
22EC603	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
22EC607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**18**	**0**	**6**	**21**	**24**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC701	MICROWAVE ENGINEERING	2	0	2	3	4	50	50	100	PC
22EC702	WIRELESS COMMUNICATION	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
22EC707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**17**	**0**	**8**	**21**	**25**	**-**	**-**	**-**	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22EC801	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 - EMBEDDED SYSTEM DESIGN										
22EC001	ADVANCED PROCESSOR ARCHITECTURES	3	0	0	3	3	40	60	100	PE
22EC003	EMBEDDED C PROGRAMMING	3	0	0	3	3	40	60	100	PE
22EC002	COMMUNICATION PROTOCOLS AND STANDARDS	3	0	0	3	3	40	60	100	PE
22EC004	REAL TIME OPERATING SYSTEMS	3	0	0	3	3	40	60	100	PE
22EC005	EMBEDDED LINUX	3	0	0	3	3	40	60	100	PE
22EC006	VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS	3	0	0	3	3	40	60	100	PE
22EC051	EMBEDDED PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3	3	40	60	100	PE
VERTICAL II - SENSOR TECHNOLOGIES AND IOT										
22EC007	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22EC008	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22EC009	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EC010	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22EC011	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22EC012	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE
22EC052	EDGE COMPUTING FOR IOT	3	0	0	3	3	40	60	100	PE

VERTICAL III- SEMICONDUCTOR CHIP DESIGN AND VERIFICATION									
22EC013	ADVANCED DIGITAL SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EC014	ANALOG VLSI DESIGN	3	0	0	3	3	40	60	100	PE
22EC015	ASIC DESIGN	3	0	0	3	3	40	60	100	PE
22EC016	LOW POWER VLSI DESIGN	3	0	0	3	3	40	60	100	PE
22EC017	DSP INTEGRATED CIRCUITS	3	0	0	3	3	40	60	100	PE
22EC018	VLSI VERIFICATION	3	0	0	3	3	40	60	100	PE
22EC053	TESTING OF VLSI	3	0	0	3	3	40	60	100	PE
VERTICAL IV - SIGNAL AND IMAGE PROCESSING										
22EC019	ADVANCED DIGITAL SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
22EC020	SPEECH SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
22EC021	DIGITAL IMAGE PROCESSING	3	0	0	3	3	40	60	100	PE
22EC022	MULTIMEDIA COMPRESSION TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EC023	COMPUTER VISION	3	0	0	3	3	40	60	100	PE
22EC024	WAVELET TRANSFORMS AND APPLICATIONS	3	0	0	3	3	40	60	100	PE
VERTICAL V – WIRED AND WIRELESS COMMUNICATION										
22EC025	UNDERWATER ACOUSTIC COMMUNICATIONS	3	0	0	3	3	40	60	100	PE
22EC026	SATELLITE COMMUNICATION	3	0	0	3	3	40	60	100	PE
22EC027	OPTICAL COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	PE
22EC028	MIMO COMMUNICATION	3	0	0	3	3	40	60	100	PE
22EC029	SIGNAL PROCESSING FOR MMWAVE COMMUNICATION	3	0	0	3	3	40	60	100	PE
22EC030	MACHINE LEARNING FOR WIRELESS COMMUNICATIONS	3	0	0	3	3	40	60	100	PE

VERTICAL VI – RADIO FREQUENCY AND ANTENNA SYSTEMS										
22EC034	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3	3	40	60	100	PE
22EC031	MICROWAVE CIRCUITS AND SYSTEMS	3	0	0	3	3	40	60	100	PE
22EC032	MICROWAVE INTEGRATED CIRCUITS	3	0	0	3	3	40	60	100	PE
22EC035	ANTENNA TECHNOLOGIES FOR WIRELESS APPLICATIONS	3	0	0	3	3	40	60	100	PE
22EC033	RF SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22EC036	SMART ANTENNAS	3	0	0	3	3	40	60	100	PE
VERTICAL VII - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING										
22EC040	PYTHON PROGRAMMING FOR AI AND ML	3	0	0	3	3	40	60	100	PE
22EC037	SOFT COMPUTING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EC038	OPTIMIZATION TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EC039	MACHINE LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EC041	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22EC042	NATURAL LANGUAGE PROCESSING	3	0	0	3	3	40	60	100	PE
VERTICAL VIII – DIVERSIFIED ELECTIVES										
22EC043	MEDICAL ELECTRONICS AND INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22EC044	CONSUMER ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EC045	NANO ELECTRONICS	3	0	0	3	3	40	60	100	PE
22EC046	AUTOMOTIVE ELECTRONICS AND NETWORKING	3	0	0	3	3	40	60	100	PE
22EC047	PCB DESIGN AND FABRICATION	3	0	0	3	3	40	60	100	PE
22EC048	CRYPTOGRAPHY AND NETWORK SECURITY	3	0	0	3	3	40	60	100	PE
22EC049	SCRIPTING LANGUAGES FOR VLSI DESIGN AUTOMATION	3	0	0	3	3	40	60	100	PE
22EC050	5G MOBILE AND WIRELESS COMMUNICATION	3	0	0	3	3	40	60	100	PE
22EC054	QUANTUM COMPUTING	3	0	0	3	3	40	60	100	PE

HONOURS - VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT										
22ECH01	ADVANCED PROCESSOR ARCHITECTURES	3	0	0	3	3	40	60	100	PE
22ECH07	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22ECH08	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22ECH09	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22ECH10	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22ECH11	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22ECH12	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE
22EC052	EDGE COMPUTING FOR IOT	3	0	0	3	3	40	60	100	PE
MINOR VERTICAL COURSES SENSOR TECHNOLOGIES AND IOT										
22ECM07	IoT PROTOCOLS AND INDUSTRIAL SENSORS	3	0	0	3	3	40	60	100	PE
22ECM08	IoT PROCESSORS	3	0	0	3	3	40	60	100	PE
22ECM09	IoT SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22ECM10	WIRELESS SENSOR NETWORK DESIGN	3	0	0	3	3	40	60	100	PE
22ECM11	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE
22ECM12	DATA ANALYTICS FOR IoT	3	0	0	3	3	40	60	100	PE
22EC052	EDGE COMPUTING FOR IOT	3	0	0	3	3	40	60	100	PE
OPEN ELECTIVES										
22OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE
22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
22OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE

22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	OE
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE
22OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	OE
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
22OFD04	CEREAL, PULSES AND OILSEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
22OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	OE
22OPH04	BIOPHOTONICS	3	0	0	3	3	40	60	100	OE
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE
22OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE
22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
22OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
22OGE04	NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE
22OBM01	OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES	3	0	0	3	3	40	60	100	OE

22OBM02	AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OBM03	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	OE
22OAG01	RAIN WATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OEE01	VALUE ENGINEERING	3	0	0	3	3	40	60	100	OE
ONE CREDIT COURSES										
22EC0XA	MIMO ANTENNA DESIGN AND ITS ANALYSIS	1	0	0	1	-	100	0	100	EEC
22EC0XB	NLP BEYOND BASICS	1	0	0	1	-	100	0	100	EEC
22EC0XC	32-BIT MICROPROCESSORS (MPUS) WITH EDGE AI	1	0	0	1	-	100	0	100	EEC
22EC0XD	IoT APPLICATION DESIGN USING LoRa TECHNOLOGY	1	0	0	1	-	100	0	100	EEC
22EC0XE	EXPERIMENTING NETWORK PROTOCOLS USING ANALYZING TOOLS	1	0	0	1	-	100	0	100	EEC
22EC0XF	AUTOMOTIVE COMMUNICATION BOOT CAMP LIN, OBD AND AUTOSAR	1	0	0	1	-	100	0	100	EEC
22EC0XG	SEMICONDUCTOR LIFE CYCLE	1	0	0	1	-	100	0	100	EEC
22EC0XH	GENERATIVE AI	1	0	0	1	-	100	0	100	EEC
22EC0XI	FROM CONCEPT TO PROTOTYPE PCB ELECTRONIC DESIGN ESSENTIALS	1	0	0	1	-	100	0	100	EEC
22EC0XJ	PROTOCOLS IN AUTOMOTIVE COMMUNICATION TECHNOLOGIES	1	0	0	1	-	100	0	100	EEC
22EC0XK	PHYSICAL COMPUTING WITH UNITY AND CONTROLLER	1	0	0	1	-	100	0	100	EEC

SUMMARY OF CREDIT DISTRIBUTION

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	4	8					32	20	15%	20%
2	ES	6	8	4						18	11	15%	20%
3	HSS	3	3	2	1					9	6	5%	10%
4	PC			11	12	16	11	7		57	35	30%	40%
5	PE				3	6	9	12		30	18	15%	20%
6	EEC					1	1	2	10	17	10	5%	10%
Total		21	21	22	24	23	21	21	10	163	100	-	-

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

22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

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

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

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	PS01	PS02
1	1	2	-	-	-	-	-	-	-	-	-	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	-
3	2	1	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

MATHEMATICS MODELING OF LINEAR FUNCTIONS

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

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

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

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

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

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

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

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

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

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

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

22PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

PO2 Identify, formulate, review research literature, and 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.

PO11 Recognize the need for, and have the preparation and ability to engage in independent and life–long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the 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	PSO1	PSO2
1	3	2	1	1	-	-	-	-	2	-	1	-	-
2	3	2	1	2	-	-	-	-	2	-	1	-	-
3	3	2	2	1	-	-	-	-	2	-	1	-	-
4	3	2	2	1	-	-	-	-	2	-	1	-	-
5	3	2	2	1	-	-	-	-	2	-	1	-	-

UNIT I **6 Hours**

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

Total: 60 Hours

Reference(s)

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

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

Course Objectives

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

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

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

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

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

UNIT III **6 Hours**
CHEMICAL BONDING
Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

UNIT IV **6 Hours**
REACTION THERMODYNAMICS
Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**
STATES OF MATTER
Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

EXPERIMENT 1 **5 Hours**
Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plant in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

EXPERIMENT 2 **5 Hours**
Investigate the amount of Iron (Fe^{2+}) in a mild steel alloy sample using a spectrophotometer.

EXPERIMENT 3 **4 Hours**
Estimate the amount of chromium present in industry effluent samples and bottled beverages.

EXPERIMENT 4 **5 Hours**
Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

EXPERIMENT 5 **3 Hours**
Assess the acidic nature of effluent water from industries using the conductometric titration method.

EXPERIMENT 6 **4 Hours**
Measure the stain removal efficiency of the prepared soaps from stained clothes.

EXPERIMENT 7 **4 Hours**
Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

Total: 60 Hours

Reference(s)

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, 2nd Edition, Oxford university press, 2020.
2. Peter Atkins, Julio D Paula and James Keeler, Atkins' Physical Chemistry, 12th Edition, Oxford university press, 2019.
3. Gareth Price, Thermodynamics of chemical processes, 2nd Edition, Oxford university press, 2019.
4. D Tabor, Gases, liquids and solids and other states of matter, 3rd Edition, Oxford University press, 2018.
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017.
6. J.D. Lee, Concise inorganic chemistry, 5th edition (Reprint), Blackman Science Ltd, France, Wiley-India, 2016.

22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

Course Objectives

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

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.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	PSO1	PSO2
1	2	1	1	1	-	-	-	-	-	-	-	1	1
2	3	3	3	1	-	-	-	-	-	-	-	1	1
3	2	2	2	1	-	-	-	-	-	-	-	1	1
4	2	2	2	1	-	-	-	-	-	-	-	-	-
5	2	2	2	1	-	-	-	-	-	-	-	-	-

UNIT I **8 Hours**

CODES AND COMBINATIONS

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

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

Communication to computing devices through various input sources - Computational operation - 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)

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

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

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

PO8. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9. 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. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply correct grammar and business-specific vocabulary to comprehend and create written communication suitably.
2. Analyse the core meaning of non-routine business correspondence and reports on both expected and unexpected subjects.
3. Develop concise factual reports and draft non-routine business letters conveying clear information.
4. Illustrate effective questioning techniques to obtain accurate information, interpret responses, and clearly relay or document messages in the workplace.
5. Design straightforward, planned presentations on well-known business topics using basic viewpoints and limited reasoning.

Articulation Matrix

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

UNIT I **15 Hours**

SELF-EXPRESSION

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

UNIT II **15 Hours**

CREATIVE EXPRESSION

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

UNIT III **15 Hours**

FORMAL EXPRESSION

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

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book 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 IGCSEA, First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **7 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 behavior 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

Program Outcomes (POs)

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

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

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

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

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

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

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

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

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

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

UNIT V **3 Hours**

COMMERCIALIZATION

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

EXPERIMENT 1 **1 Hours**

Analysis of various business sectors

EXPERIMENT 2 **2 Hours**

Developing a Design Thinking Output Chart

EXPERIMENT 3 **1 Hours**

Creating Buyer Personas

EXPERIMENT 4 **3 Hours**

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**

Preparation of Business Model Canvas

EXPERIMENT 6 **15 Hours**

Developing Prototypes

EXPERIMENT 7 **2 Hours**

Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**

Preparation of Business Plans

EXPERIMENT 9 **2 Hours**

Preparation of Pitch Decks

Total: 45 Hours

Reference(s)

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

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

Course Objectives

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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

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

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

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

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

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

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

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

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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

Total: 15 Hours

Reference(s)

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

22HS003 தமிழர் மரபு **1 0 0 1**

பாடத்திட்டத்தின் நோக்கம்

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.

கற்றலின் விளைவு

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.
4. தமிழ் மொழியின் சிறப்புகளை அதன் படைப்பிலக்கியங்கள் மூலம் அறிந்து கொள்ளுதல்.
5. கற்காலம் தொடங்கி, இக்காலம் வரை சிற்பக்கலை அடைந்த வளர்ச்சியை கண்டுகொள்ளல்.
6. தமிழர் தம் வாழ்வில் எங்கனம் இயற்கையை வணங்கி போற்றினர் என்பதை திணை கோட்பாட்டின் வழி தெளிதல்.
7. இந்திய விடுதலை போரில் தமிழர் ஆற்றிய பங்கினை தெரிந்து கொள்ளுதல்.

அலகு I மொழி மற்றும் இலக்கியம்: **3**

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

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

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

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

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

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

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

PO2 Problem analysis: Identify, formulate, review research literature, and analyze 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	PS01	PS02
1	1	2	-	-	-	-	-	-	-	-	-	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I 9 Hours

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

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

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

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

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

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

UNIT V **9 Hours**

COMPLEX FUNCTIONS

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

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

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

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

PO11 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 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	PSO1	PSO2
1	3	2	1	1	-	-	-	-	2	-	1	-	-
2	3	2	1	2	-	-	-	-	2	-	1	-	-
3	3	2	2	1	-	-	-	-	2	-	1	-	-
4	3	2	2	1	-	-	-	-	2	-	1	-	-
5	3	2	2	1	-	-	-	-	2	-	1	-	-

UNIT I **6 Hours**
ELECTRICITY
Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor-Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

UNIT II **6 Hours**
MAGNETISM
Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

UNIT III **6 Hours**
ELECTROMAGNETIC WAVES AND LIGHT
Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

UNIT IV **6 Hours**
MODERN PHYSICS
Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

UNIT V **6 Hours**
ENERGY BANDS IN SOLIDS
Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

EXPERIMENT 1 **5 Hours**
Analysis a I-V characteristics of a solar cell for domestic applications

EXPERIMENT 2 **5 Hours**
Determine the carrier concentration of charge carriers in semiconductors for automotive applications

EXPERIMENT 3 **5 Hours**
Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 4 **5 Hours**
Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

EXPERIMENT 5 **5 Hours**
Assess the variation of refractive index of glass and water for optical communication

EXPERIMENT 6 **5 Hours**
Evaluate the band gap energy of semiconducting materials for display device applications

Total: 60 Hours

Reference(s)

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

22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	-
3	2	1	-	-	-	-	1	-	-	-	-	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-
5	2	1	-	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

ELECTROCHEMISTRY

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

UNIT II **6 Hours**

ENERGY STORING DEVICES

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

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

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

UNIT IV **6 Hours**

CATALYSIS

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

UNIT V **6 Hours**

NUCLEAR REACTIONS

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

EXPERIMENT 1 **4 Hours**

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

EXPERIMENT 2 **4 Hours**

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

EXPERIMENT 3 **4 Hours**

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

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

EXPERIMENT 5 **4 Hours**

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

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application

EXPERIMENT 7 **5 Hours**

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

Total: 60 Hours

Reference(s)

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

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

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

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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I

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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	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 SPECIAL REQUIREMENTS

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

EXPERIMENT 1 — 6 Hours

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

EXPERIMENT 2 — 6 Hours

Design and construct regulated DC power supply for Mobile phone charger

EXPERIMENT 3 — 6 Hours

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

EXPERIMENT 4 **6 Hours**

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

EXPERIMENT 5 **6 Hours**

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

Total: 60 Hours

Reference(s)

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

22GE005 ENGINEERING DRAWING **1 0 2 2**

Course Objectives

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

Program Outcomes (POs)

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

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

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

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

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

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

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

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

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

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

Total: 45 Hours

Reference(s)

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

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objectives

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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I 3 Hours

WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

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

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

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

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

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

UNIT V **3 Hours**

SCIENTIFIC TAMIL & TAMIL COMPUTING

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

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils , A joint publication of TNTB & ESC and RMRL
2. Dr.S.Singaravelu , Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian ,Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi , The Contributions of the Tamils to Indian Culture, International 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 தொழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் நோக்கம்

1. சங்க காலத்தில் வரலாறு மற்றும் கலாச்சார ஆவணங்களின் ஒரு வடிவமாக, மட்பாண்டங்கள் மீதான கிராஃபிட்டியை பகுப்பாய்வு செய்தல்.
2. சிலப்பதிகாரத்தில் கட்டப்பட்ட மேடை கட்டுமானங்களின் விவரங்களையும் அவற்றின் கலாச்சார முக்கியத்துவத்தையும் பகுப்பாய்வு செய்வதன் மூலம், சங்க காலத்தில் மாவீரர் கற்களின் கட்டுமானப் பொருட்கள் மற்றும் வரலாற்று சூழலை ஆராய்தல்.
3. சமுத்திரங்கள் பற்றிய பண்டைய அறிவையும், தமிழ் சமூகத்தில் அதன் தாக்கத்தையும் ஆராய்வது ஆகியவை இப்பாடத்திட்டத்தின் நோக்கம் ஆகும்.

கற்றலின் விளைவு

1. சங்க காலத்தில் நெசவுத் தொழிலின் முக்கியத்துவத்தையும் அதன் கலாச்சார முக்கியத்துவத்தையும் புரிந்து கொள்ளல்.
2. சோழர் கால விவசாய மற்றும் நீர்ப்பாசன நடைமுறைகளில் அணைகள், குளங்கள் மற்றும் மதகுகளின் முக்கியத்துவத்தைப் புரிந்து கொள்ளல்.
3. சங்க காலத்தில் வீட்டுப் பொருட்களில் பயன்படுத்தப்பட்ட கட்டடக்கலை வடிவமைப்புகள் மற்றும் கட்டமைப்பு கட்டுமான முறைகளை ஆராய்தல்.
4. பண்டைய தமிழ் கலாச்சாரத்தில், கப்பல் கட்டும் கலை, கடல் வர்த்தகம் மற்றும் போக்குவரத்தில் அதன் பங்கை ஆராய்தல்.
5. தமிழ் மொழியில் அறிவியல் சொற்களஞ்சியம் மற்றும் சொல்லகராதியின் வளர்ச்சியைக் கண்டறிதல்.

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

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

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

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

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

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

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

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

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

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

TOTAL : 15 PERIODS

Reference(s)

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City 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 ACTIVITIE

Course Objectives

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

Program Outcomes (POs)

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

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

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

PO11 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

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

Articulation Matrix

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

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

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

Co-Curricular activity

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

Extracurricular activity

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

Total: 40 Hours

22EC301 PROBABILITY, STATISTICS AND RANDOM PROCESS

3 1 0 4

Course Objectives

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

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Demonstarte the concepts of basic probability axioms and apply it the core areas of engineering.
2. Apply the concepts of probability distributions in an appropriate place of science and engineering.
3. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Analyze the concepts of random process techniques to the problems of random input signals.

Articulation Matrix

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

UNIT I **9 Hours**

PROBABILITY AND RANDOM VARIABLE

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

UNIT II **9 Hours**

STANDARD DISTRIBUTIONS

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

UNIT III **9 Hours**

TESTING OF HYPOTHESIS

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

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS AND CONTROL CHART

One way and two way classifications - Completely randomized design - Randomized block design - Latin square design. Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts)

UNIT V **9 Hours**

RANDOM PROCESSES

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

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

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

22EC302 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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. Determine 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. Determine driving point and transfer function of two port networks and classify different two port networks.

Articulation Matrix

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

UNIT I **9 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, Thevenins theorem, Nortons 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, TASKs 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.

22EC303 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	PSO1	PSO2
1	2	1	2	-	-	-	-	-	-	-	-	1	1
2	1	2	3	2	-	-	-	-	-	-	-	1	1
3	1	3	2	3	-	-	-	-	-	-	-	1	1
4	1	2	3	3	3	-	-	-	-	-	-	1	1
5	1	2	2	3	-	-	-	-	-	-	-	1	1

UNIT I **6 Hours**

NUMBER SYSTEMS AND CODES

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

UNIT II **10 Hours**

BOOLEAN THEOREMS AND LOGIC REDUCTION

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

UNIT III **10 Hours**

COMBINATIONAL LOGIC CIRCUITS

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

UNIT IV **10 Hours**

SEQUENTIAL LOGIC CIRCUITS

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

UNIT V **9 Hours**

COUNTERS, LOGIC FAMILIES AND PLDS

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

EXPERIMENT 1 **2 Hours**

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

EXPERIMENT 2 **3 Hours**

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

EXPERIMENT 3 **5 Hours**

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

EXPERIMENT 4 **5 Hours**

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

EXPERIMENT 5 **5 Hours**

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

EXPERIMENT 6 **5 Hours**

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

EXPERIMENT 7 **5 Hours**

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

Total: 75 Hours

Reference(s)

1. M. Morris Mano and Michael D. Ciletti, Digital Design, Pearson, 5th Edition, 2013
2. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015
3. A.Anand Kumar, Fundamentals of Digital Circuits, 4th Edition PHI Learning Private Limited, 2016
4. Charles H. Roth, Jr., Fundamentals of Logic Design, 2014, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US.
5. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009

22EC304 ANALOG ELECTRONICS AND INTEGRATED CIRCUITS **3 0 2 4**

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

BIASING

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

UNIT II **9 Hours**

FEEDBACK AMPLIFIERS AND POWER AMPLIFIERS

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

UNIT III **9 Hours**

OP-AMP CHARACTERISTICS

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

UNIT IV **9 Hours**

WAVEFORM GENERATORS

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

UNIT V **9 Hours**

COMPARATORS, DATA CONVERTERS AND SPECIAL FUNCTION ICS

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

EXPERIMENT 1 **8 Hours**

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

EXPERIMENT 2 **8 Hours**

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

EXPERIMENT 3 **8 Hours**

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

EXPERIMENT 4 **6 Hours**

Design and implementation of Analog Temperature Monitor with ADC

Total: 75 Hours

Reference(s)

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

22EC305 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.

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.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application-oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	PSO1	PSO2
1	3	1	1	3	3	-	-	-	-	-	-	1	1
2	2	-	-	2	2	-	-	-	-	-	-	1	1
3	1	2	-	3	2	-	-	-	-	-	-	1	1
4	1	-	-	3	2	-	-	-	-	-	-	1	1
5	1	3	1	3	3	-	-	-	-	-	-	1	1

UNIT I

INTRODUCTION

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

UNIT II **7 Hours**

LINEAR LIST: STACKS, QUEUES AND LISTS

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

UNIT III **6 Hours**

SORTING AND SEARCHING

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

UNIT IV **5 Hours**

NON LINEAR LIST: TREES

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

UNIT V **6 Hours**

GRAPHS

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

EXPERIMENT 1 **4 Hours**

Design an MP3 player using singly linked list and its operations.

EXPERIMENT 2 **3 Hours**

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

EXPERIMENT 3 **4 Hours**

Implementation of storing a web browser's history.

EXPERIMENT 4 **4 Hours**

Interrupt handling in real-time systems.

EXPERIMENT 5 **3 Hours**

Design a program to implement a phonebook using sorting.

EXPERIMENT 6 **4 Hours**

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

EXPERIMENT 7 **4 Hours**

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

EXPERIMENT 8 **4 Hours**

Scanning a hierarchical file system directory structure.

Total: 60 Hours

Reference(s)

1. F.Richard Gilberg, 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.

Program Outcomes (POs)

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.

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	PSO1	PSO2
1	-	-	-	-	-	-	-	3	2	1	-	-	-
2	-	-	-	-	-	-	-	3	2	1	-	-	-
3	-	-	-	-	-	-	-	3	2	1	-	-	-
4	-	-	-	-	-	-	-	3	2	1	-	-	-
5	-	-	-	-	-	-	-	3	2	1	-	-	-

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

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

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

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

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

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

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

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

UNIT V **6 Hours**

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

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

Total: 30 Hours

Reference(s)

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

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION 0 0 2 1

Course Objectives

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

Programme Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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	PSO1	PSO2
1	2	-	-	-	-	-	-	2	2	-	2	-	-
2	2	3	-	-	-	-	-	2	2	-	2	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-

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

22EC401 SIGNALS AND SYSTEMS 3 1 0 4

Course Objectives

- Understand the Mathematical Representation of Signals and Systems
- Interpret the concept of Linear Time Invariant Systems and the Convolution property.
- Represent Continuous Time and Discrete Time signals using Fourier Series and Fourier Transform
- Represent Continuous Time and Discrete Time systems using Laplace and z Transforms

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze a given signal or a system by applying the mathematical representation.
2. Apply the concept of Convolution to predict the behavior of a given Linear Time Invariant System
3. Analyze the frequency domain representation of a given Continuous Time periodic signal using Fourier Series and aperiodic signal using Fourier Transform
4. Analyze the frequency domain representation of a given Discrete Time periodic signal using Discrete Time Fourier series and aperiodic signal using Discrete Time Fourier Transform.
5. Analyze the frequency response and stability of a Continuous Time System using Laplace Transform and Discrete Time System using z Transform.

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION TO SIGNALS AND SYSTEMS

Definition of Signal, Classification of Signals, Elementary Signals, Operations on Signals, Correlation of Signals, Definition of System, Classification of Systems.

UNIT II **8 Hours**

TIME DOMAIN ANALYSIS OF LINEAR TIME INVARIANT SYSTEMS

Concept of Impulse Response, Convolution Integral and Convolution Sum, Properties of LTI Systems, Interconnection of LTI Systems, System Stability.

UNIT III **9 Hours**

FREQUENCY DOMAIN ANALYSIS OF CONTINUOUS TIME SIGNALS

Continuous Time Fourier Series (CTFS), Properties of CTFS, Continuous Time Fourier Transform (CTFT), Properties of CTFT, Gibbs Phenomena, Dirichlet Conditions.

UNIT IV **8 Hours**

FREQUENCY DOMAIN ANALYSIS OF DISCRETE TIME SIGNALS

Discrete Time Fourier Series, Properties of DTFS, Discrete Time Fourier Transform, Properties of DTFT, Comparison of CTFS, CTFT, DTFS and DTFT.

UNIT V **10 Hours**

FREQUENCY DOMAIN ANALYSIS OF SYSTEMS

Laplace Transform, Properties of Laplace Transform, Stability of Continuous Time Systems, Frequency Response of Continuous Time Systems, The z Transform, Properties of z Transform, Stability of Discrete Time Systems, Frequency Response of Discrete Time Systems.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, 2nd Edition, Pearson, 2013.
2. Principles of Linear Systems and Signals, B. P. Lathi, 2nd Edition, Oxford University Press, 2009.
3. Signals and Systems, Simon Haykin, Barry Van Veen, 2nd Edition, John Wiley & Sons, 2007.
4. Signals and Systems, Tarun Kumar Rawat, Oxford University Press, 2010.
5. Signals, Systems, Transforms, and Digital Signal Processing with MATLAB, Michael Corithios, CRC Press, 2018.

22EC402 ANALOG COMMUNICATION 3 0 2 4

Course Objectives

- To analyze various analog modulation and demodulation techniques.
- To describe the behavior of analog communications in the presence of noise and also analyze the noise performance of various AM and FM receivers.
- To design and analyze various Pulse analog modulations.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the mathematical model for generation and detection of different AM systems based on time domain representation and its spectrum
2. Design of FM Transmission & Reception system and analyze it with its mathematical model.
3. Analyze the effect of noise on communication receivers.
4. Compare the noise performance of AM and FM receivers.
5. Apply the concepts of the sampling process and determine the characteristics of Pulse Analog Modulation schemes.

Articulation Matrix

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

UNIT I **9 Hours**

AMPLITUDE MODULATION SYSTEMS

Generation and demodulation of AM, DSB-SC, SSB-SC, VSB Signals, Filtering of sidebands, Comparison of Amplitude modulation systems, Frequency translation, Frequency Division multiplexing, AM transmitters, AM receivers.

UNIT II **9 Hours**

FREQUENCY MODULATION SYSTEMS

Angle modulation, frequency modulation, Narrowband and wideband FM, transmission bandwidth of FM signals, Generation of FM signal: Direct FM, indirect FM, Demodulation of FM signals, FM stereo multiplexing, PLL: Nonlinear model and linear model of PLL, Non-linear effects in FM systems, FM Broadcast receivers, FM stereo receiver.

UNIT III **9 Hours**

NOISE PERFORMANCE OF DSB, SSB RECEIVERS

Noise: Shot noise, thermal noise, White noise, Noise equivalent Bandwidth, Narrowband noise, Representation of Narrowband noise in terms of envelope and phase components, Sine wave plus Narrowband Noise, Receiver model, Noise in DSB-SC receiver, Noise in SSB receiver.

UNIT IV **9 Hours**

NOISE PERFORMANCE OF AM AND FM RECEIVERS

Noise in AM receivers threshold effect, Noise in FM receivers capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and de-emphasis in FM, Comparison of performance of AM and FM systems.

UNIT V **9 Hours**

PULSE MODULATION

Sampling process: sampling theorem for band limited signals, ideal and practical sampling, Anti-aliasing and reconstruction filters, Generation and detection of Pulse Amplitude Modulation (PAM), Generation and detection of Pulse Width Modulation (PWM), Generation and detection of Pulse Position Modulation (PPM), Generation and detection of Pulse Time Modulation (PTM), Time division Multiplexing, Crosstalk effect.

EXPERIMENT 1 **7 Hours**

Design and Construct AM Radio Circuit to receive radio signal from all India radio.

EXPERIMENT 2 **7 Hours**

Design and Construct FM Radio Circuit to receive radio signal from BIT FM.

EXPERIMENT 3 **8 Hours**

Generate a Pulse width modulated signal using a Controller and vary the speed of the DC motor using the PWM signal.

EXPERIMENT 4 **8 Hours**

Generate an audio file and music file with different frequencies. Develop a mixer circuit to produce single output by combining both signals.

Total: 75 Hours

Reference(s)

1. Simon Haykin, Communication Systems, John Wiley & sons, NY, 5th Edition, 2016
2. Michael P. Fitz, Fundamentals of Communication Systems, Tata McGraw-Hill, 2nd Edition-2013.
3. Taub and Schilling, Principles of communication systems, TMH, New Delhi, 4th Edition, 2017.
4. Bruce Carlson et al, Communication systems, McGraw-Hill Int., 4th Edition, 2007.
5. Michael Moher Simon Haykin, An Introduction to Analog & Digital Communications, 2nd Edition, 2012.

22EC403 ELECTROMAGNETIC FIELDS AND WAVEGUIDES

3 1 0 4

Course Objectives

- To understand the concepts of electrostatics, electric potential, energy density, magnetostatics and their applications.
- To analyse the electric field in material space and understand to solve boundary value problems
- To apply Maxwells equations to determine field waves, potential waves, energy and charge conservation conditions

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Apply vector calculus to static electromagnetic fields and analyse the behaviour of static electric field of various geometries and its scalar potential using Coulomb"s Law and Gauss Law.
2. Analyze the behavior of static magnetic field for various applications and its vector potential using Biot-Savart Law and Amperes Circuital Law.
3. Analyze the boundary conditions of electric and magnetic field and determine the capacitance and inductance of various geometries.
4. Analyze Maxwells equation in different forms to determine field waves, potential waves, energy and charge conservation conditions.
5. Analyze the concept of propagating modes, TE and TM decomposition, evanescent modes and cut off frequency in waveguides.

Articulation Matrix

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

UNIT I **9 Hours**

ELECTROSTATIC FIELDS

Coordinate System, Del- Gradient- Divergence- Curl, Coulomb"s Law - Electric Field Intensity and its analysis of various geometries -Electric Scalar Potential - Relationship between potential and electric field-electric flux density- Gauss Law and its Applications.

UNIT II **9 Hours**

MAGNETOSTATICS FIELDS

Biot- Savart Law and Field Intensity - Analysis of Magnetic Field intensity due to various geometries - Amperes Circuital Law and its Applications -Magnetic Scalar and Vector Potentials-Magnetic Flux Density.

UNIT III **9 Hours**

ELECTROMAGNETIC FIELDS IN MATERIAL SPACE AND BOUNDARY VALUE PROBLEMS

Boundary Condition - Boundary conditions for electric fields. Capacitance - Capacitance of various geometries using Laplace equation- - Magnetic boundary conditions- Inductors-inductances - magnetic energy stored in inductors, EMI/EMC concepts and definitions, Sources of EMI.

UNIT IV **9 Hours**

TIME VARYING ELECTROMAGNETIC FIELDS

Maxwells Equations -Time-Varying Potentials. Wave Propagation-Helmholtz wave Equation-wave motion in free space- perfect dielectric- lossy dielectric and good conductor- skin effect. Poynting vector and power considerations.

UNIT V **9 Hours**

WAVEGUIDES

Plane Waves- Waves between parallel planes of perfect conductors, Rectangular waveguides- Transverse Magnetic (TM) Modes -Transverse Electric (TE) Modes, Impossibility of TEM waves in waveguides, Dominant mode in rectangular wave guide, Velocities of propagation.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Matthew Sadiku,Elements of Electromagnetics,Oxford University seventh edition-2018
2. Edward C. Jordon, Keith G. Balmain,Electromagnetic Waves and Radiating Systems,Pearson, prentice hall.2015
3. Joseph A. Edminister, Theory and Problems of Electromagnetics-Schaum series-TMH-4/E-2014
4. William H Hayt, John A Buck, Engineering Electromagnetics, McGraw-Hill Higher Education, 8th edition, 2011
5. J.D. Kraus and D.A Fleisch, Electromagnetics with applications,5/e-Tata McGraw-Hill- 2017.
6. Bhag Guru and Huseyin Hiziroglu, Electromagnetic Field Theory Fundamentals, Cambridge University Press, 2nd edition, 2009

22EC404 CMOS DIGITAL INTEGRATED CIRCUITS 3 0 2 4

Course Objectives

- To understand the CMOS fabrication process, circuits and physical design
- To design and analyze the MOS circuits using various logic styles.
- To analyze the different test methods for CMOS circuits

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Attribute various fabrication technologies used to represent MOS circuits.
2. Design MOS circuits and analyze the factors influencing the operation of CMOS transistors
3. Analyze the different styles to construct CMOS logic circuits.
4. Analyze CMOS logic to design various digital modules for VLSI system design
5. Analyze the different methods to test VLSI circuits

Articulation Matrix

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

UNIT I **9 Hours**

FABRICATION OF CMOS IC AND PHYSICAL DESIGN

Silicon Semiconductor technology: Wafer processing, Oxidation, Epitaxy, Diffusion and Silicon gate process, NMOS fabrication , CMOS fabrication: n-well, p-well, Twin tub and SOI Process , Layout design rules , Stick Diagrams, CMOS Logic Gate, Implementation of given logic function using CMOS logic.

UNIT II **9 Hours**

MOS CIRCUIT DESIGN PROCESS

Basic MOS transistors: Symbols, Enhancement mode, Depletion mode transistor operation - Regions of operation, Second order effects of MOSFET, MOS Scaling, Fundamental limits of MOS scaling , CMOS inverter: DC Characteristics, Power dissipation.

UNIT III **9 Hours**

CMOS LOGIC STYLES

Static CMOS design, Pass Transistor, Transmission Gate, Tri State Circuits, Pseudo Nmos, Clocked CMOS logic , Dynamic CMOS logic: Domino logic, Charge Keeper Circuits , Dual Rail logic networks: Cascode Voltage Switch Logic.

UNIT IV **9 Hours**

VLSI SYSTEM COMPONENTS

Ripple Carry Adder, Carry Look Ahead Adder, Carry Skip Adder, Carry select Adder, Carry save Adder, Multiplier, Array, Booth, Baugh Wooley.

UNIT V **9 Hours**

TESTING OF VLSI CIRCUITS

Importance of testing, Challenges in VLSI Testing, Faults in digital circuits, Fault models in CMOS, Test pattern generation methods: Path sensitization, Boolean Difference, Built in self test.

EXPERIMENT 1 7 Hours

Design and implementation of audio volume control using CMOS transistors.

EXPERIMENT 2 7 Hours

Design and implementation of automated car parking system

EXPERIMENT 3 8 Hours

Design a temperature control system for a greenhouse to maintain an optimal environment for plant growth

EXPERIMENT 4 8 Hours

Design and simulation of Digital Calculator using EDA tools

Total: 75 Hours

Reference(s)

1. Neil.H. E Weste David Harris CMOS VLSI Design: A Circuits and Systems Perspective, 4th edition, Pearson Addison Wesley, 2015.
2. John P. Uyemura, Introduction to VLSI circuits and systems, John Wiley, 2016.
3. Kamran Eshraghian, Douglas A. Pucknell, Essentials of VLSI Circuits and Systems Prentice Hall of India, 2015.
4. Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill, 2014
5. Rabaey, Chandrakasan and Nikolic, Digital Integrated Circuit: A design Perspective, PHI, Second Edition ,2016.
6. Abramovici .M, Breuer M.A and Friedman A.D, Digital Systems and Testable Design, Jaico Publishing House, 2002.

22EC405 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Construct the 8086 architecture and write ALP for 8086 processor.
2. Breakdown hardware and software architectures of Embedded Systems
3. Analyse the special features and architecture of TIVA C series microcontroller.
4. Analyse and program different communication protocols used for Embedded Networking.
5. Design embedded applications by interfacing the OFF-chip peripherals with the microcontroller.

Articulation Matrix

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

UNIT I **9 Hours**

8086 MICROPROCESSOR

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

UNIT II **9 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

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

UNIT III **9 Hours**

TIVA-C MICROCONTROLLER

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

UNIT IV **9 Hours**

COMMUNICATION PROTOCOLS

UART, ADC, PWM, Timer, I2C, SPI

UNIT V **9 Hours**

OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING

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

EXPERIMENT 1 **4 Hours**

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

EXPERIMENT 2 **4 Hours**

Design a display system for hotel using 8086 microprocessors.

EXPERIMENT 3 **5 Hours**

Design a ranking system for students using 8086 microprocessors.

EXPERIMENT 4 **5 Hours**

Design a traffic light controller using TIVA-C microcontroller.

EXPERIMENT 5 **6 Hours**

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

EXPERIMENT 6 **6 Hours**

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

Total: 75 Hours

Reference(s)

1. Ray K & Bhurchandi K.M, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interface", 3rd Edition, McGraw Hill, New Delhi, 2012.
2. Prasad K V K K Embedded Real Time Systems Concepts, Design and Programming Dreamtech press 2013
3. Muhammad Ali Mazidi, 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

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

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

Course Outcomes (COs)

1. Apply principles of natural resource management to analyze exploitation cases in forestry, water, minerals, and agricultural sectors, assessing their environmental impacts.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Analyze the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Analyze the impacts of population and human activities on environment

Articulation Matrix

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

UNIT I **6 Hours**

NATURAL RESOURCES

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

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

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

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

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

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

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

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

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

Total: 30 Hours

Reference(s)

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

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION

0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- Effectively use the appreciate the nuances of the language and engage an audience
- Use advanced tools of language to improve communicative competence and prepare for professional demands at the workplace

Program Outcomes (POs)

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

PO10 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. 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	PSO1	PSO2
1	-	-	-	-	-	-	-	-	2	3	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-

UNIT I **15 Hours**

CREATIVE EXPRESSION

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

UNIT II **15 Hours**

FORMAL EXPRESSION

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

Course Objectives

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

Program Outcomes (POs)

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

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

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

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

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

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

PO11 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

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

Articulation Matrix

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

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

Total: 40 Hours

22EC501 DIGITAL COMMUNICATION 3 0 2 4

Course Objectives

- To infer the basics of different Digital communication techniques
- To interpret the basics concept of information theory
- To demonstrate the concept and details of error control coding techniques

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze Pulse Code Modulation schemes for digitizing analog signals and apply digital multiplexing concept for different applications
2. Design a system that transmits baseband signals with minimum distortion and analyze the level of ISI using eye pattern
3. Analyze the performance of different digital modulation /demodulation techniques
4. Evaluate the efficiency of source coding for data compression of digital data transmission
5. Perform channel coding for error detection/controlling of digital data transmission

Articulation Matrix

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

UNIT I **9 Hours**

PULSE MODULATION

Sources and Signals, Basic Signal Processing Operations in Digital Communication, Channels for Digital Communication.Review of Sampling process (Qualitative): Low pass and Band pass sampling, Aliasing, Signal Reconstruction Quantization: Uniform & non uniform quantization, quantization noise, Logarithmic Companding of speech signal Waveform coding: Pulse Code Modulation (PCM), Differential pulse code modulation, Adaptive differential pulse code modulation, Delta modulation

UNIT II **9 Hours**

BASEBAND TRANSMISSION

Line codes: Need for line shaping of signals, Properties of Line codes, Power Spectral Density of Unipolar / Polar RZ & NRZ, Bipolar NRZ, Manchester, Matched Filter, Inter symbol Interference, Nyquist criterion for distortion less transmission. Pulse shaping and raised cosine filter, Correlative coding, M ary schemes, Eye pattern, Equalization

UNIT III **9 Hours**

CARRIER MODULATION

Signal Representation: Orthogonality, Representation of Signals, Generation and detection of Amplitude Shift Keying (ASK) Modulation, Generation and detection of Frequency Shift Keying (FSK) Modulation, Generation and detection of Binary Phase Shift Keying (BPSK) Modulation, Generation and detection of Quaternary Phase Shift Keying QPSK) and QAM Performance of BPSK, QPSK and QAM in AWGN channel structure of Non-coherent Receivers, Principle of DPSK.

UNIT IV **9 Hours**

INTRODUCTION TO INFORMATION THEORY

Measure of information, entropy. Channel capacity and Shannons theorems, source coding techniques: Prefix code, Huffman Coding, Shannon Fano Elias Coding, Arithmetic Coding, Run length code. Channel capacity, channel coding theorem, Information capacity theorem

UNIT V **9 Hours**

ERROR CONTROL CODING

Channel coding theorem, Linear Block codes, Hamming codes, Cyclic codes, Convolutional codes, Viterbi Decoder, Turbo Codes.

EXPERIMENT 1 **6 Hours**

Transmit and decode an audio signal (voice, music) with and without sampling which should involve reading an audio file and selecting specific samples to decode the signal.

EXPERIMENT 2 **6 Hours**

Design a Wi-Fi (IEEE 802.11) standard at 2.4. GHz using any simulator to test practically the wifi topology in the lab environment.

EXPERIMENT 3 **6 Hours**

Determine the coverage area, number of users, bandwidth requirements, and security needs during voice transmission in mobile communication.

EXPERIMENT 4 **6 Hours**

Design a RFID card reader that uses QPSK modulation for long-range communication with low power consumption.

EXPERIMENT 5 **6 Hours**

Compute error rate in the transmission of data using Bluetooth device for voice and image transmission among the users.

Total: 75 Hours

Reference(s)

1. Simon Haykins, Communication Systems John Wiley & Sons 4th Edition, 2016.
2. B.P. Lathi, Communication Systems, BS Publication, 2004.
3. K. Sam Shanmugam, Analog and Digital Communication, Wiley, 2005.
4. Proakis, J.G., Salehi, M., Digital Communications, 5th Ed., McGraw-Hill International,2008.
5. Couch II, L.W., Digital and Analog Communication Systems, 7th Ed., Pearson, 2009.
6. Sklar, B., Digital Communications, 2nd Ed., Pearson, 2001.

22EC502 DIGITAL SIGNAL PROCESSING 3 0 2 4

Course Objectives

- To analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
- To design IIR filters for given specifications by following the suitable design procedures
- To design FIR filters for given specifications by following the suitable design procedures
- To analyze the finite word length effect in the design of digital signal processing systems
- To understand the architectural overview and addressing modes in DSP processors

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
2. Construction of Realization structures and design for IIR filters
3. Construction of Realization structures and design for FIR filters
4. Analyze the effect of finite word length for fixed & floating point number representation.
5. Develop an algorithm using TSM320C6X Processor for simple signal processing applications.

Articulation Matrix

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

UNIT I **9 Hours**

DISCRETE FOURIER TRANSFORM: PROPERTIES, APPLICATIONS AND COMPUTATION

The Discrete Fourier Transform, Need for DFT, DFT as a linear transformation. Properties of DFT, Linear Filtering based on DFT-Circular Convolution, Efficient Computation of DFT-Radix-2 FFT algorithm, Applications of FFT algorithm.

UNIT II **9 Hours**

DESIGN OF IIR FILTERS

Introduction to FIR and IIR filters, General consideration in the design of digital filters, 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.

UNIT III **9 Hours**

DESIGN OF FIR FILTERS

Linear phase FIR filters, Design of FIR Filters, Frequency sampling technique, Windowing technique. Design of FIR Differentiators, Realization of FIR filters, Direct and Linear phase realization structures.

UNIT IV **9 Hours**

FINITE WORD LENGTH EFFECT IN DIGITAL FILTERS

Fixed and Floating Point Number Representation, Quantization Noise, Finite Word Length Effects in Digital filters, Input Quantization, Product Quantization, Coefficient quantization error, Limit Cycle Oscillations, Introduction to Multirate Signal Processing, Interpolation, Decimation.

UNIT V **9 Hours**

DIGITAL SIGNAL PROCESSORS

Introduction to Digital Signal Processors, Basic Classification, Features. TMS320C6713 Architecture, Functional Unit, Pipelining, Addressing Modes, Instruction set, Simple Assembly Language Program.

EXPERIMENT 1 **7 Hours**

Design of spectrum analyser for audio systems

EXPERIMENT 2 **7 Hours**

Dual role of noise canceller as enhancer in headphones

EXPERIMENT 3 **8 Hours**

Peak signal analyser with IIR filters for Pulse Oximeter Signal Applications

EXPERIMENT 4 **8 Hours**

Ultrasonic image edge detection in frequency domain for analyzing tumour size.

Total: 75 Hours

Reference(s)

1. Digital Signal Processing by John G. Proakis and Dimitris K. Manolakis, 4th edition, Pearson Education India
2. Chasssing, Rulph, DSP applications using C and the TMS320C6x DSK. Vol 13. John Wiley and Sons,2003
3. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
4. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY.
5. Understanding Digital Signal Processing, Lyons, Richard G., 3/e, Pearson Education India,2004
6. Digital Signal Processing: A Practical Approach, Barrie W. Jervis and Emmanuel C. I feachor 2 edition, Pearson Education India,2009

22EC503 TRANSMISSION LINES AND ANTENNAS 3 0 2 4

Course Objectives

- To understand the different types of transmission lines at radio frequencies.
- To determine the radiation field of different wire antennas and analyze its parameters.
- To analyze and design travelling wave antennas and derive the radiation fields of aperture and slot antennas.
- To understand the characteristics of signals in sky wave, space wave and ground wave propagation mechanisms.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Find the voltage, current and impedance of the transmission line as a function of its characteristics impedance and propagation constant.
2. Analyze the characteristics of the transmission line at radio frequencies and apply smith chart for impedance matching.
3. Determine the radiation fields of different wire antennas, array antennas and analyze its fundamental parameters
4. Analyze the fields of different travelling wave antennas and compute the radiation fields of the Huygens source, aperture, slot and complementary dipole antennas.
5. Analyze the refractive, reflection and attenuation characteristics of the sky wave, space wave and ground wave propagation and explain the gain and directivity measurements of the antenna.

Articulation Matrix

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

UNIT I **9 Hours**

TRANSMISSION LINE THEORY

Different types of transmission lines, transmission line as a cascade of T Sections- Characteristic impedance and Propagation Constant. General Solution of the transmission line- wavelength and velocity of propagation, Distortions, Distortion less transmission line. The telephone cable- Inductance loading of telephone cables.

UNIT II **9 Hours**

THE LINE AT RADIO FREQUENCIES

Input impedance of lossless lines. Standing waves and standing wave ratio on a line, Input impedance of a lossless line terminated by impedance- One eighth wave line, Quarter waveline, Half wave line. Smith chart- Application of the Smith Chart, single stub matching.

UNIT III **9 Hours**

ANTENNA FUNDAMENTALS AND RADIATION FIELDS OF WIRE ANTENNAS

Concept of retarded vector potential- Half-wave dipole and folded dipole. Antenna Parameters, Reciprocity theorem and Friis transmission formula. Linear arrays- N-element Uniform linear array, Principle of pattern multiplication, Broadside and End-fire array- Array synthesis: Binomial array.

UNIT IV **9 Hours**

TRAVELING WAVE ANTENNAS

Analysis of V antenna. Analysis and Design of Rhombic antenna, Aperture concept, Huygens principle, Radiation from a rectangular aperture treated as an array of Huygens sources. Babinets principle- Equivalence of fields of a slot and complementary dipole, Horn antennas, parabolic reflector antennas.

UNIT V **9 Hours**

PROPAGATION AND ANTENNA MEASUREMENTS

Sky wave propagation: Refractive index, Critical frequency. Skip distance. Effect of earth"s magnetic field. Maximum usable frequency. Space wave propagation: Reflection from ground for vertically and horizontally polarized waves, Duct propagation. Ground wave propagation: Attenuation characteristics for ground wave propagation.

EXPERIMENT 1 **4 Hours**

Construct the transmission line to transmit the signal without any loss for the FM radio station.

EXPERIMENT 2 **4 Hours**

Design and simulate the wired antennas for the TV reception system.

EXPERIMENT 3 **4 Hours**

Design and simulate the array antennas to transmit/ receive the signals in the 4G Airtel network

EXPERIMENT 4 **4 Hours**

Design and simulate the array antenna to avoid interference in a wireless environment of the 5G Jio network

EXPERIMENT 5 **4 Hours**

Construct the Cellular antenna set up to measure the radiation pattern.

EXPERIMENT 6 **5 Hours**

Design and simulate the Microstrip Patch antenna for mobile applications.

EXPERIMENT 7 **5 Hours**

Design and simulate the Microstrip slot antenna for wi-fi applications

Total: 75 Hours

Reference(s)

1. Constantine A. Balanis, Antenna Theory Analysis and Design, John Wiley, 3rd Edition, 2016.
2. K.D. Prasad, Antenna and Wave Propagation, Sathya Praksham, 2001.
3. E.C. Jordan & K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall of India 2nd edition 2003.
4. J.D. Ryder, Networks, Lines and Fields, PHI, 2nd Edition, 2010.
5. Warren L. Stutzman, Gary A. Thiele, Antenna Theory and Design, Wiley, 3rd Edition 2012.
6. Miano, Giovanni, and Maffucci, Antonio, Transmission Lines and Lumped Circuits: Fundamentals and Applications, Ukraine, Elsevier Science, 2001.

22EC504 INTERNET OF THINGS AND ITS APPLICATIONS **3 0 2 4**

Course Objectives

- To evaluate the performance of STM32 Microcontroller.
- To analyze the various protocols of IoT with application development.
- To analyze the distinct architecture and framework of LoRa WAN IoT.
- To evaluate the diverse applications of IOT.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyse the specifications of STM32 Microcontroller.
2. Breakdown the architecture, monitoring and controlling by IoT with target boards.
3. Analyse the various protocols of IOT deployed in applications.
4. Differentiate the architecture and procedure involved in communication through LoRa and LoRaWAN.
5. Execute IoT in desperate applications.

Articulation Matrix

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

UNIT I **9 Hours**

STM32 MICROCONTROLLER

ARM Cortex-M Processors - Instruction Set Architecture - Data Flow and Register Set- GPIO Registers - ADC-USART-I2C-Timers

UNIT II **9 Hours**

IoT ARCHITECTURE -STATE OF THE ART

IoT reference Model and Architecture- Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, Middleware Introduction-Fi Ware etc., Remote monitoring and sensing, remote controlling and performance analysis, layering concepts, communication pattern, 6LoWPAN, Sensors and sensor Node and interfacing using any Embedded Target boards.

UNIT III **9 Hours**

IoT APPLICATION DEVELOPMENT

IoT Protocols - Protocol Standardization for IoT - Efforts - M2M and WSN Protocols, Application protocols: IEEE802.15.4 - Modbus, MQTT, REST/HTTP, MySQL, Back-end Application Designing Apache for handling HTTP Requests, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, IoT Devices and deployment models.

UNIT IV **9 Hours**

LoRaWAN IoT

LoRaWAN architecture, Difference between LoRa and LoRaWAN architecture, Configuring Gateway for LoRa Communication, Introduction to Application Server, Data Monitoring & Device Control between End Node and Application server using LoRa communication & MQTT/HTTP, Introduction to Open Source LoRaWAN Server, Configuring Gateway for LoRaWAN Communication.

UNIT V **9 Hours**

CASE STUDIES

Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps towards a Secure Platform, Data Aggregation for the IoT in Smart Cities, IoT applications for industry: Industry 4.0, Future Factory Concepts, Brownfield IoT, Smart Objects.

EXPERIMENT 1 **6 Hours**

Real-Time Weather Monitoring and Cloud-Based Data Logging.

EXPERIMENT 2 **6 Hours**

Real-Time IoT Monitoring and Cloud Integration for Industrial Safety: Vibration Detection and Hazardous Gas Monitoring.

EXPERIMENT 3 **6 Hours**

Real-Time Soil Nutrient Monitoring for Smart Agriculture.

EXPERIMENT 4 **6 Hours**
Real-Time IoT Integration for Smart Manufacturing: Interfacing PLC-Controlled Conveyor.

EXPERIMENT 5 **6 Hours**
Industrial Energy Monitoring by Interfacing EL Energy Meter.

Total: 75 Hours

Reference(s)

1. Geoffrey Brown, Discovering the STM32 Microcontroller, Indiana University, 2016.
2. Colin Dow, Perry Lea, Mastering IOT, Packt Publishing, First Published by 2019.
3. Mohammad Ali Jabraeil Jamali, Bahareh Bahrami, Arash Heidari, Parisa Allahverdizadeh, Farhad Norouzi, Towards the Internet of Things, Architectures, Security, and Applications, Springer International Publishing, 2020.
4. Information Resources Management Association, Smart Cities and Smart Spaces Concepts, Methodologies, Tools, and Applications, IGI Global, 7 September 2018.
5. Cristian Gonzalez Garcia, Vicente Garcia-Diaz, IoT Protocols and Applications for Improving Industry, Environment, and Society, IGI Global, 2021

22EC507 MINI PROJECT I 0 0 2 1

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Find a real world problem, identify the requirement and develop the design solutions.
2. Predict 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	PSO1	PSO2
1	1	2	1	1	2	-	2	2	2	-	-	1	1
2	1	2	1	1	2	-	2	2	2	-	-	1	1
3	1	2	1	1	2	-	2	2	2	2	-	1	1
4	1	2	1	1	2	-	2	2	2	2	-	1	1
5	1	2	-	-	2	-	2	2	2	-	-	1	1

22EC601 COMPUTER NETWORKS AND PROTOCOLS

3 0 0 3

Course Objectives

- To understand the fundamental concept of networks and issues involved in the network system.
- To acquire an insight view and knowledge to design various layer protocols.
- To realize the concepts of application layer protocol including client/server models.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Use OSI and TCP/IP models, basic topologies with emerging computer networks.
2. Apply the appropriate random access protocols, flow and error control schemes to solve the data link layer issues.
3. Analyze the network layer impairments for switchingtechniques, routing algorithms and protocols.
4. Analyze the performance of transport layer protocols by adopting suitable congestion control schemes.
5. Apply the knowledge of application layer protocols to design energy efficient networks.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NETWORKS

Network architecture, Topology, Types (LAN, MAN, WAN &PAN), Network Switching Types: Circuit and packet switching, OSI Reference Model, TCP/IP model, Comparison. Different types of transmission media, Errors in transmission: attenuation, noise, Repeaters.

UNIT II **9 Hours**

DATA LINK LAYER

MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols, IEEE standards: Ethernet, Token Ring, Bluetooth, Wi-Fi, VLAN, Error detection codes: Parity, CRC, Checksum.

UNIT III **9 Hours**

NETWORK LAYER

Internet Protocol, IPv4, IPv6, ARP, DHCP, Inter domain routing, Subnetting, Classless addressing, Network Address Translation.

UNIT IV **9 Hours**

TRANSPORT LAYER

Connectionless: UDP, Connection Oriented: TCP Connection establishment and termination, flow and congestion control, Noiseless channel: Stop and Wait, Noisy channel: Stop and Wait ARQ, Go back N ARQ, Selective repeat ARQ.

UNIT V **9 Hours**

APPLICATION LAYER

DNS, Electronic Mail: SMTP, POP3, IMAP, Client server &P2P Architecture, HTTP, SNMP.

Total: 45 Hours

Reference(s)

1. Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011.
2. W Stallings, Cryptography and Network Security, Principles and Practice, 5th Ed., Prentice-Hall, 2010
3. Srinivasan Keshav - Mathematical Foundations of Computer Networking-Addison-WesleyProfessional (2012)
4. Andrew S. Tanenbaum, "Computer Networks", Fifth Edition, Pearson Education India, 2013.
5. Michael Donahoo, Ken Calvert, Pocket Guide to TCP/IP Socket Programming in C, Morgan Kaufmann Series in Networking, 2000.

22EC602 DIGITAL SYSTEM DESIGN WITH FPGA 3 0 2 4

Course Objectives

- To understand the capabilities of PLDs and FPGA IC technologies
- To perform Verilog FPGA Programming
- To realize the digital systems in an FPGA

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the different programmable IC technologies
2. Design a digital logics using Verilog HDL
3. Design a digital logics using advanced Verilog HDL and verify using test bench
4. Design a digital systems using Verilog HDL
5. Design a advanced digital system using Verilog HDL

Articulation Matrix

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

UNIT I **9 Hours**

PROGRAMMABLE IC TECHNOLOGIES

PROM, PLA, PAL, CPLD Programmable IC Technologies: Introduction to FPGA, FPGA Implementation Process, FPGA EDA Tools, FPGA Internal Architectures, Actel ACT1, Function generators, Xilinx FPGA Internal Architecture, LUT- Programmable Interconnections.

UNIT II **9 Hours**

BASICS OF VERILOG HDL

Importance of HDL: Design Methodologies, Basic Concepts, Data Types, Verilog Operators, Dataflow Modeling, Gate Level Modeling, Behavioural Modeling: if, else, case statement, For, While Loop: Design Examples.

UNIT III **9 Hours**

ADVANCED VERILOG HDL

Switch Level Modeling: Tasks, Functions, User Defined Primitives (UDP), Timing and Delays, Verilog Test Benches for Combinational Logic Modules and Sequential Digital Circuits - Design Examples.

UNIT IV **9 Hours**

SYSTEM DESIGN USING VERILOG

ALU: Magnitude Comparator, Multiplication Unit, Adder/Subtractor, MAC Unit, Universal Shift Register, Barrel Shifter, Random Number Generator.

UNIT V **9 Hours**

ADVANCED DIGITAL SYSTEM DESIGN USING VERILOG

Traffic Light Controller: Vending Machine Controller, Single and Dual Port RAM, Real Time Clock, PCI Arbiter Design, Nth Order W-bit FIR & IIR Filter with Constant Coefficients, FIFO.

EXPERIMENT 1 4 Hours

Design and Implementation of 16 Bit Magnitude Comparator using Behavioral HDL.

EXPERIMENT 2 4 Hours

Design of Universal shift register using Structural Modeling.

EXPERIMENT 3 5 Hours

Design and Implementation of Adder/Subtractor Design using HDL.

EXPERIMENT 4 5 Hours

Design and Implementation ALU using HDL.

EXPERIMENT 5 6 Hours

Design and Simulation of Real Time Clock using Behavioral HDL.

EXPERIMENT 6 **6 Hours**

Design and Simulation of Traffic Light Controller FSM using Behavioral HDL.

Total: 75 Hours

Reference(s)

1. Ming Bo Lin, Wiley, Digital System Designs and Practices using Verilog HDL and FPGAs, 2012.
2. Samir Palnitkar, Verilog HDL, Pearson Education,2ndEdition,2004.
3. J. Bhaskar, A Verilog Primer, Prentice Hall, 2005.
4. Bob Zeidman, Designing with FPGAs and CPLDs, Elsevier, CMP Books, 2002.
5. Ion Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier, 2008.

22EC603 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

3 0 2 4

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTELLIGENT AGENTS

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

UNIT II **9 Hours**

PROBLEM SOLVING

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

UNIT III **9 Hours**

MACHINE LEARNING METHODS

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

UNIT IV **9 Hours**

REINFORCEMENT LEARNING

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

UNIT V **9 Hours**

AI APPLICATIONS

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

EXPERIMENT 1 **4 Hours**

Develop PEAS descriptions for given AI Experiment.

EXPERIMENT 2 **5 Hours**

Implement basic search strategies for selected AI applications.

EXPERIMENT 3 **5 Hours**

Implement a classifier for the sales data.

EXPERIMENT 4 **5 Hours**

Develop a predictive model for predicting house prices.

EXPERIMENT 5 **5 Hours**

Apply reinforcement learning and develop a game of your own.

EXPERIMENT 6 **6 Hours**

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

Total: 75 Hours

Reference(s)

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

22EC607 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Find a real-world problem, identify the requirements, and develop the design solutions.
2. Assess 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	PSO1	PSO2
1	1	2	1	1	2	-	2	2	2	-	-	1	1
2	1	2	1	1	2	-	2	2	2	-	-	1	1
3	1	2	1	1	2	-	2	2	2	2	-	1	1
4	1	2	1	1	2	-	2	2	2	2	-	1	1
5	1	2	-	-	2	-	2	2	2	-	-	1	1

22EC701 MICROWAVE ENGINEERING 2 0 2 3

Course Objectives

- To understand the importance of various microwave components in several communication applications.
- To study the performance of microwave components using certain performance estimation parameters
- To understand the fundamental concepts about microwave semiconductor devices

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the working and performance of RF and its network characterisation of waveguide.
2. Analyze the working and performance of Microwave signal generators.
3. Analyze the working of high frequency semiconductor devices.
4. Analyze the measurement techniques using microwave test bench, Vector Network Analyzer and Spectrum Analyzer
5. Analyze the performance of planar transmission lines.

Articulation Matrix

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

UNIT I **6 Hours**

HIGH FREQUENCY NETWORK CHARACTERIZATION

Scattering Parameters: Definition, Chain Scattering Matrix, Conversion of S-parameters, Generalized S-parameters and Practical Measurements; S parameter representation of N port networks, properties - S Matrix of a Directional Coupler- waveguide tees and rat race coupler-Qualitative discussion on: Waveguide Corners- Bends- Twists- Matched loads and movable shorts.

UNIT II **6 Hours**

MICROWAVE SIGNAL GENERATOR

Two cavity Klystron amplifier - Transit time effect- Velocity modulation - current modulation-bunching - Reflex Klystron-Slow-Wave structures - Helix Travelling -Wave Tubes- Convection Current- Axial Electric Field- Wave Modes- Bandwidth, Power and Gain Considerations - cross field device. Magnetron - power and frequency considerations.

UNIT III **6 Hours**

HIGH FREQUENCY SEMICONDUCTOR DEVICES

Gunn-Effect -Gunn Diode- Differential Negative Resistance- Modes of Operation-Amplification-Microwave Generation Read Diode- Physical Description- Avalanche Multiplication IMPATT Diodes-TRAPATT Diode- BARITT Diode-Principles of Operation- Physical Structures; RF Bipolar Junction Transistor

UNIT IV **6 Hours**

MICROWAVE MEASUREMENTS

Slotted line VSWR measurement- impedance measurement- insertion loss and attenuation measurements-measurement of scattering parameters - Return loss measurement using directional coupler-Introduction to vector network analyzer and its uses- return loss and insertion loss-Measurement of return loss and Insertion loss using Spectrum analyzer.

UNIT V **6 Hours**

PLANAR TRANSMISSION LINES

Introduction- Microstrip Lines- Derivation of Characteristic Impedance of Microstrip Lines using Quasi Static analysis- Losses in Microstrip Lines- Quality Factor Q of Microstrip Lines- Parallel Strip Lines-Characteristic Impedance-Attenuation losses- Coplanar Strip Lines- Shielded Strip Line-Problems

EXPERIMENT 1 **4 Hours**

Construct and analyze the performance of radar signal generator from 8 to 12Ghz for a military application to monitor the air defence system

EXPERIMENT 2 **4 Hours**

Construct a radar signal generator with 10Ghz frequency using Gunn Diode and analyse the Voltage(V) and Current (I) characteristics and predict the negative differential resistance region of Gunn diode

EXPERIMENT 3 **4 Hours**
Construct a radar signal frequency generator, and measure the wavelength, amount of attenuation generated and verify the condition for impedance matching network

EXPERIMENT 4 **6 Hours**
Construct a microwave network using E-plane, H-Plane and Magic Tee and analyse its power flow and choose a device to connect two radars, one for short range with 10dB of input power and assign the remaining power to long range detection radar

EXPERIMENT 5 **4 Hours**
Construct a x-band signal generator and predict the frequency of transmission and analyse the signal power received by horn and parabolic dish antenna at a distance point.

EXPERIMENT 6 **4 Hours**
Analyse the propagation of microwave power transmitted to a three port network device and a two port device

EXPERIMENT 7 **4 Hours**
Performance analysis of received signal power due to a dipole antenna and parabolic dish antenna.

Total: 60 Hours

Reference(s)

1. David.M. Pozar, Microwave Engineering, John Wiley, 2003
2. Samuel.Y. Liao, MicrowaveDevices and Circuits, PHI, 2000.
3. Reinhold Ludwig, Gene Bogdanow, RF Circuit Design-Therory and Applications, Pearson, 2011
4. Annapurna Das and SisirK.Das, Microwave Engineering, Tata Mc Graw-Hill,2000.
5. R.E. Collin, Foundations for Microwave Engineering - IEEE Press 2002.International, 1999.
6. Sushrut Das, Microwave Engineering, Oxford university Press, 2014

22EC702 WIRELESS COMMUNICATION 3 0 2 4

Course Objectives

- To impart the fundamental concepts of wireless communication systems.
- To compare various technologies and protocols involved in wireless cellular communication
- To understand the concepts of signalling schemes for fading channels and analyze its channel capacity.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Assess wave propagation mechanisms and reason for fading to select the appropriate propagation path loss model depending on wireless channel model.
2. Apply innovative ideas in the field of wireless communication, in particular how to communicate effectively and efficiently in wireless cellular communication.
3. Compare the performance of various digital signaling techniques implemented in fading channels of wireless systems.
4. Analyse the mathematical framework for design of wireless systems developed based on suitable equalization and diversity techniques.
5. Apply the innovative ideas to improve the existing technology in the field of digital communication through Multiple access techniques and multicarrier modulation

Articulation Matrix

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

UNIT I **9 Hours**

WIRELESS CHANNELS

Electromagnetic Wave Propagation Mechanisms, Reflection, Diffraction, Scattering Models, Large scale path loss, Path loss models: Free Space and Two-Ray models, Link Budget design, Small scale fading- Parameters of mobile multipath channels, Time dispersion Parameters-Coherence bandwidth, Doppler spread and Coherence time, fading due to Multipath time delay spread, flat fading, frequency selective fading, Fading due to Doppler spread, fast fading, slow fading.

UNIT II **9 Hours**

CELLULAR MOBILE WIRELESS SYSTEMS

Cellular concept, Frequency reuse, channel assignment Strategies, Hand off, Interference and system capacity, Trunking & grade of service, Coverage and capacity improvement.

UNIT III **9 Hours**

DIGITAL SIGNALING FOR FADING CHANNELS

Modulation techniques: Offset-QPSK, p/4-DQPSK, MSK- GMSK, M QAM, M PSK, OFDM, Spread Spectrum Systems: PN sequence, m sequence, Direct Sequence Spread Spectrum, Frequency Hopping Spread Spectrum.

UNIT IV **9 Hours**

EQUALIZATION AND DIVERSITY TECHNIQUES

Fundamentals of equalization, Equalizers in communication receivers: Linear equalization, Non-linear equalization: DFE, MLSE Equalizer, Adaptive Equalizer. Diversity Techniques: Time diversity, Antenna diversity, Frequency diversity, Polarization diversity, RAKE Receiver

UNIT V **9 Hours**

MULTIPLE ACCESS TECHNIQUES AND MULTICARRIER MODULATION

Multiple Access techniques, FDMA, TDMA, CDMA, OFDMA- Multicarrier Modulation, Data Transmission Using Multiple Carriers, Multicarrier Modulation with Overlapping Sub channels, Mitigation of Subcarrier Fading, Coding with Interleaving over Time and Frequency, Frequency Equalization, Challenges in Multicarrier Systems, Case Study: OFDM design in the Wi-Fi Standard.

EXPERIMENT 1 **5 Hours**

Performance analysis of a walkie-talkie system by modelling signal attemnuation using
Free Space Path Loss (FSPL) for open field communication.
Log-Normal Shadowing for urban or obstructed environments.
Two Ray Ground Reflection Model for Vehicle-to-Vehicle (V2V) Communication

EXPERIMENT 2 **5 Hours**

Performance analysis and Simulation of Frequency Reuse and Cell Coverage in Urban 5G Networks by Visualizing Hexagonal Cell Layout and Co-Channel Interference Analysis for Dense City Deployment and network planning

EXPERIMENT 3 **5 Hours**

Performance Analysis of BPSK and QPSK over Rayleigh and Rician Fading Channels for Wireless Communication Systems in Urban and Suburban Environments.

EXPERIMENT 4 **5 Hours**

Simulation of Direct Sequence Spread Spectrum (DSSS) Modulation and Demodulation for Secure Wireless Communication Applications.

EXPERIMENT 5 **5 Hours**

Simulation and Analysis of ZF, MMSE, and Adaptive Equalizers for Drone-to-Base Communication in a Disaster Recovery Networks.

EXPERIMENT 6 **5 Hours**

Simulation of CDMA and OFDM Based Multiuser Transmitter and Receiver Using MATLAB for 5G IoT and Wi-Fi Network Applications.

Total: 75 Hours

Reference(s)

1. Cory Beard and William Stallings, "Wireless Communication Networks and Systems" Pearson, 2015.
2. ITI Saha Misra, "Wireless Communication and Networks: 3G and beyond", McGraw Hill Education Pvt Ltd., Second edition, 2013.
3. K. Daniel Wong, "Fundamentals of Wireless Communication Engineering Technologies" Wiley, 2012.
4. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
5. T.S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Pearson Education/ Prentice Hall of India, Third Indian Reprint 2003.
6. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005

22EC707 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Find a real-world problem, identify the requirements, and develop the design solutions.
2. Assess 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 the oral demonstrations.

Articulation Matrix

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

22EC801 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Find a real-world problem, identify the requirement, and develop the design solutions.
2. Assess 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 the oral demonstrations.

Articulation Matrix

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

22HS201 COMMUNICATIVE ENGLISH II 1 0 22

Course Objectives

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills to comprehend complex content
- Enhance confidence in expressing with clarity and elegance with enthusiastic and reflective use of the language

Programme Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one’s own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **15 Hours**

SELF-EXPRESSION

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

UNIT II **15 Hours**

CREATIVE EXPRESSION

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

UNIT III **15 Hours**

FORMAL EXPRESSION

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting 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

22HSH01 HINDI 1 0 2 2

Course Objectives

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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

VOWELS AND CONSONANTS

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

UNIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

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

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

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

UNIT V **9 Hours**

CONVERSATIONS

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

Total: 45 Hours

Reference(s)

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

22HSG01 GERMAN 1 0 2 2

Course Objectives

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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

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

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

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

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

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

UNIT IV **9 Hours**

INTERROGATION

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

UNIT V **9 Hours**

IMPLEMENTATION

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

Total: 45 Hours

Reference(s)

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

22HSJ01 JAPANESE 1 0 2 2

Course Objectives

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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese (Hiragana (Katakana) Long owels - Pronunciation of in, tsu, ga -Letters combined with ya, yu, yo - Daily Greetings and Expressions - umerals. 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

Program Outcomes (POs)

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

ENTRER EN CONTACT

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

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

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

UNIT III **9 Hours**

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

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

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

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

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

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

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

Total: 45 Hours

Reference(s)

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

22EC001/22ECH01 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	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.

22EC002 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	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

22EC003 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

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	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.

22EC004 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.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	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

22EC005 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

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	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

22EC006 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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

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	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.

22EC007/22ECH07/22ECM07 IoT PROTOCOLS AND INDUSTRIAL SENSORS

3 0 0 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO IOT

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

UNIT II **9 Hours**

IOT COMMUNICATION PROTOCOLS

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

UNIT III **9 Hours**

TRANSPORT

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

UNIT IV **9 Hours**

MOTION, PROXIMITY AND RANGING SENSORS

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

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

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

Total: 45 Hours

Reference(s)

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

22EC008/22ECH08/22ECM08 IoT PROCESSORS 3 0 0 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO EMBEDDED CONCEPTS

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

UNIT II **9 Hours**

OVERVIEW OF ARM AND CORTEX M3

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

UNIT III **9 Hours**

CORTEX EXCEPTION HANDLING AND INTERRUPTS

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

UNIT IV **9 Hours**

CORTEXM3/M4 PROGRAMMING

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

UNIT V **9 Hours**

CORTEXM3/M4 DEVELOPMENT AND DEBUGGING TOOLS

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

Total: 45 Hours

Reference(s)

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

22EC009/22ECH09/22ECM09 IoT SYSTEM DESIGN 3 0 0 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF IOT

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

UNIT II **9 Hours**

IOT PROTOCOLS

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

UNIT III **9 Hours**

DESIGN AND DEVELOPMENT

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

UNIT IV **9 Hours**

DATA ANALYTICS AND SUPPORTING SERVICES

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

UNIT V **9 Hours**

CASE STUDIES/INDUSTRIAL APPLICATIONS

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

Total: 45 Hours

Reference(s)

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

22EC010/22ECH10/22ECM10 WIRELESS SENSOR NETWORK DESIGN

3 0 0 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze basics and technologies for wireless networks
2. Analyze and compare various architectures of Wireless Sensor Networks
3. Analyze design issues and challenges in wireless sensor networks
4. Develop the infrastructure and its simulations
5. Demonstrate, the concept of programming in the WSN environment

Articulation Matrix

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

UNIT I **10 Hours**

OVERVIEW OF WIRELESS SENSOR NETWORKS

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

UNIT II **10 Hours**

ARCHITECTURES

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

UNIT III **9 Hours**

NETWORKING SENSORS

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

UNIT IV **8 Hours**

INFRASTRUCTURE ESTABLISHMENT

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

UNIT V **8 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS

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

Total: 45 Hours

Reference(s)

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

22EC011/22ECH11/22ECM11 INDUSTRIAL IoT AND INDUSTRY 4.0 **3 0 0 3**

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze about the evolution of Industry 4.0 in smart factories and cyber physical systems
2. Find the process of industrial automation system network and control
3. Demonstrate the reference architectural models and business models with key enabling technologies
4. Analyse the data of the industrial IoT systems with security
5. Apply the technologies to various sectors and case study the application of Industrial IoT in smart industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND KEY TECHNOLOGIES

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

UNIT II **9 Hours**

INDUSTRIAL AUTOMATION AND IOT

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

UNIT III **9 Hours**

INDUSTRIAL DATA TRANSMISSION AND COMPUTING

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

UNIT IV **9 Hours**

DATA ANALYTICS AND SECURITY

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

UNIT V **9 Hours**

APPLICATIONS OF IIOT

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

Total: 45 Hours

Reference(s)

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

22EC012/22ECH12/22ECM12 DATA ANALYTICS FOR IoT

3 0 0 3

Course Objectives

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

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO DATA ANALYSIS AND PYTHON

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

UNIT II **9 Hours**

BASIC OPERATIONS USING PYTHON

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

UNIT III **9 Hours**

DATA ANALYSIS

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files

UNIT IV **9 Hours**

DATA MANUPULATION

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

UNIT V **9 Hours**

DATA VISUALIZATION

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

Total: 45 Hours

Reference(s)

1. Fabio Nelli, Python Data Analytics, APRESS, 2015
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK, 2020
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK, 2015
4. Peters Morgan, Data Analysis from Scratch with Python, AI Sciences, 2016
5. Agus kurniawan, Micropython for ESP8266 Development workshop, PE PRESS, 2016
6. Charles Bell, MicroPython for the internet of Things, Apress, 2017

22EC013 ADVANCED DIGITAL SYSTEM DESIGN 3 0 0 3

Course Objectives

- Understand the concepts of Synchronous and Asynchronous Sequential Circuit Design.
- Analyze the concepts of Fault Diagnosis and Testability Algorithms for digital circuits.
- Illustrate the concepts of programmable logic devices and system design Using VHDL.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Demonstrate the design of synchronous sequential circuit
2. Analyze the design of asynchronous sequential circuit
3. Find and analyze the fault diagnosis and testing
4. Design the PLD and ROM
5. Design and use programming tools for implementing digital circuits of industry standards.

Articulation Matrix

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

UNIT I **9 Hours**

SEQUENTIAL CIRCUIT DESIGN

Analysis of Clocked Synchronous Sequential Networks (CSSN) Modeling of CSSN - State Stable Assignment and Reduction - Design of CSSN -Design of Iterative Circuits - ASM Chart -ASM Realization.

UNIT II **9 Hours**

ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN

Analysis of Asynchronous Sequential Circuit (ASC) - Flow Table Reduction - Races in ASC - State Assignment -Problem and the Transition Table - Design of ASC - Hazards.

UNIT III **9 Hours**

FAULT DIAGNOSIS AND TESTING

Fault Table Method - Path Sensitization Method - Boolean Difference Method - Tolerance Techniques - Fault in PLA - Test Generation - Built- in Self Test.

UNIT IV **9 Hours**

SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES

EPROM to Realize a Sequential Circuit- Programmable Logic Devices - Designing a Synchronous Sequential Circuit using a GAL - EPROM - Realization State machine using PLD.

UNIT V **9 Hours**

SYSTEM DESIGN USING VHDL

VHDL Description of Combinational Circuits - Arrays -VHDL Operators - Compilation and Simulation of VHDL Code -Modeling using VHDL - Flip Flops - Registers - Counters - Sequential Machine - Combinational Logic Circuits - VHDL Code for - Serial Adder, Binary Multiplier - Binary Divider.

Total: 45 Hours

Reference(s)

1. G. Donald Givone, Digital principles and Design, Tata McGraw Hill 2003.
2. N. Nripendra Biswas, Logic Design Theory, Prentice Hall of India, 2001.
3. H. Charles Roth, Digital System Design using VHDL, Third Edition, Cengage Learning, 2016.
4. H. Charles Roth, Fundamentals of Logic design, Sventh Edition, Cengage Learning, 2014.
5. Stephen Brown and Zvonk Vranesic, Fundamentals of Digital Logic with VHDL Design, Tata McGraw Hill, 2008.

22EC014 ANALOG VLSI DESIGN 3 0 0 3

Course Objectives

- To understand the basics of analog integrated circuits
- To understand the basic building blocks like current sources, sinks and mirrors
- To comprehend the performance metrics of amplifier circuits and design single stage amplifiers
- To understand differential amplifiers and common mode rejection ratio
- To design an operational amplifier and operational transconductance amplifier

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Design the MOSFET models at different frequencies
2. Analyze and design current sources and voltage references for given specifications
3. Analyze and design single stage MOS amplifiers
4. Analyze CMOS differential amplifiers
5. Analyze and design CMOS operational amplifiers

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ANALOG VLSI

MOS design considerations in Analog Circuit Design, Recent Trends in Analog VLSI Circuits, Low Frequency MOSFET models, Temperature effects in MOSFET, Noise in MOSFET

UNIT II **9 Hours**

CMOS SUBCIRCUITS

MOS Switch, MOS Diode/ Active Resistor, Simple Current Sinks and Sources, Basic Current Mirrors, Current and Voltage References, and Bandgap references

UNIT III **9 Hours**

CMOS AMPLIFIERS

Performance Metrics of amplifier circuits, Common Source Amplifier, Common Gate Amplifier, Frequency Response of Amplifiers, Stability of Amplifiers

UNIT IV **9 Hours**

CMOS DIFFERENTIAL AMPLIFIER

Differential Signaling, Source Coupled Pair, Current Source Load, Common Mode Rejection Ratio, CMOS Differential amplifier with Current Mirror Load, Differential to single-ended Conversion

UNIT V **9 Hours**

CMOS OPERATIONAL AMPLIFIER

Block Diagram of Op-Amplifier, Ideal characteristics of Op-Amplifier, Design of two stages Op-Amplifier, Compensation and Frequency response of Op-Amplifier, Operational Transconductance Amplifier

Total: 45 Hours

Reference(s)

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Second Edition, McGraw-Hill, 2000
2. R. Jacob Baker, CMOS: Circuit Design, Layout and Simulation, Third Edition, Wiley Publication, 2010
3. Tony Chan Carusone, David A. Johns, Kenneth W. Martin, Analog Integrated Circuit Design, Second Edition, Wiley Publication,2011
4. Behzad Razavi, Fundamentals of Microelectronics, Second Edition, Wiley Publication, 2013
5. Phillip Allen, Douglas Holmberg, CMOS Analog Circuit Design, Second Edition, Oxford University Press, 2004

22EC015 ASIC DESIGN 3 0 0 3

Course Objectives

- The course focuses on the semi-custom IC Design and introduces the principles of design logic cells, I/O cells and interconnect architecture, with equal importance given to FPGA and ASICstyles.
- The entire FPGA and ASIC design flow is dealt with from the circuit and layout design point of view.

Program Outcomes (POs)

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

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze different CMOS logics for ASIC library design
2. Analyze the different techniques available in programmable ASICs
3. Construct the programmable ASIC architecture
4. Demonstrate the different techniques available in logic synthesis, placement and routing
5. Apply high performance algorithms to design ASICs

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell - Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance.

UNIT II **9 Hours**

PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS

Anti-fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs.

UNIT III **9 Hours**

PROGRAMMABLE ASIC ARCHITECUTRE

Architecture and configuration of Spartan and Virtex FPGAs - Micro-Blaze based embedded systems - Signal probing techniques.

UNIT IV **9 Hours**

LOGIC SYNTHESIS, PLACEMENT AND ROUTING

Logic synthesis - ASIC floor planning- placement and routing - power and clocking strategies.

UNIT V **9 Hours**

HIGH PERFORMANCE ALGORITHMS FOR ASICS/ SOCS. SOC CASE STUDIES

DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. Case Studies: Digital camera, SDRAM.

Total: 45 Hours

Reference(s)

1. M.J.S. Smith, "Application - Specific Integrated Circuits", Pearson,2003
2. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.
3. Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
4. Jose E. France, YannisTsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994.
5. Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, "FPGA-based Implementation of Signal Processing Systems", Wiley, 2008
6. Steve Kilts, "Advanced FPGA Design", Wiley Inter-Science

22EC016 LOW POWER VLSI DESIGN 3 0 0 3

Course Objectives

- Identify sources of power in an IC.
- Identify the power reduction techniques based on technology independent and technology dependent.
- Power dissipation mechanism in various MOS logic style.
- Identify suitable techniques to reduce the power dissipation.
- Design memory circuits with low power dissipation.

Program Outcomes (POs)

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

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze different sources of power dissipation in VLSI circuits
2. Apply the different techniques involved in low power adders and multipliers
3. Analyze leakage power reduction mechanism at device level and circuit level
4. Analyze the techniques involved in low power SRAM
5. Apply advanced and special techniques for reducing power consumption in memories

Articulation Matrix

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

UNIT I **9 Hours**

POWER DISSIPATION IN CMOS

Basics of power dissipation in CMOS Field Effect Transistors - Hierarchy of limits of power - Sources of power consumption - Static Power Dissipation, Active Power Dissipation - Designing for Low Power, Circuit Techniques for Leakage Power Reduction - Basic principle of low power design.

UNIT II **9 Hours**

POWER OPTIMIZATION

Logic level power optimization - Circuit level low power design - Standard Adder Cells, CMOS Adders Architectures-BiCMOS adders - Low Voltage Low Power Design Techniques, Current Mode Adder.

UNIT III **9 Hours**

DESIGN OF LOW POWER CMOS CIRCUITS

Computer arithmetic techniques for low power system - low voltage low power static Random access and dynamic Random access memories - low power clock, inter connect and layout design.

UNIT IV **9 Hours**

POWER ESTIMATION

Power Estimation techniques - logic power estimation - Simulation power analysis - Probabilistic power analysis.

UNIT V **9 Hours**

SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER

Synthesis for low power - Behavioral level transform - software design for low power.

Total: 45 Hours

Reference(s)

1. Kaushik Roy and S.C. Prasad, "Low power CMOS VLSI circuit design", Wiley, 2000.
2. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.
3. Kiat-send Yeo, Kaushik Roy "Low-Voltage, Low-power VLSI Subsystem", Tata McGraw-Hill, 2009
4. AbdelatifBelaouar, Mohamed. I. Elmasry, "Low power digital VLSI design", Kluwer, 1995.
5. A.P. Chandrasekaran and R.W. Broadersen, "Low power digital CMOS design", Kluwer,1995.
6. DimitriosSoudris, C. Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002.

22EC017 DSP INTEGRATED CIRCUITS 3 0 0 3

Course Objectives

- To understand the importance of DSP IC design
- To analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
- To analyse the DSP architectures and implementation methods
- To develop various arithmetic strategies for the design of digital signal processing systems
- To design a various digital signal processing elements

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the DSP IC and CMOS Technologies
2. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
3. Analyze the DSP architectures and its implementation
4. Organize an Arithmetic Architectures required for processing a digital signal
5. Design an VLSI architecture for the Signal Processing Elements

Articulation Matrix

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

UNIT I **9 Hours**

DSP INTEGRATED CIRCUITS AND VLSI CIRCUIT TECHNOLOGIES

Standard digital signal processors-Application specific ICs for DSP-DSP systems-DSP system design-Integrated circuit design-MOS transistors-MOS logic

UNIT II **9 Hours**

DSP ARCHITECTURES

DSP system architectures-Standard DSP architecture-Ideal DSP architectures-Multiprocessors and Multicomputers-Systolic and Wave front arrays

UNIT III **9 Hours**

SYNTHESIS OF DSP ARCHITECTURES

Shared memory architectures-Mapping of DSP algorithms onto hardware-Shared memory architecture with Bit-serial PEs

UNIT IV **9 Hours**

ARITHMETIC ELEMENTS

Conventional number system-Redundant Number System-Residue Number System-Bit-parallel and Bit-Serial Arithmetic-Minimum Number of Basic Operations-Bit Serial Squarers-Serial/Serial Multipliers-Digit Serial Arithmetic.

UNIT V **9 Hours**

SIGNAL PROCESSING ELEMENTS

CORDIC Algorithm-Distributed Arithmetic-Basic shift accumulator-Reducing the memory size-Complex Multipliers-Improved shift-accumulator-FFT Processor-DCT Processor

Total: 45 Hours

Reference(s)

1. Lars Wanhammer, DSP Integrated Circuits, Academic press, New York 1999.
2. Oppenheim A.V. Schafer, R.W., and Buck, J.R. Discrete-time Signal Processing, Pearson education, 2000
3. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital signal processing-A Practical Approach, Second edition, Pearson education, Asia 2001
4. Keshab K. Parhi, VLSI digital Signal Processing Systems design and Implementation, John Wiley & Sons, 1999
5. John G. Proakis and Dimitris K. Manolakis, Digital Signal Processing, 4th edition, Pearson Education India, 2001

22EC018 VLSI VERIFICATION 3 0 0 3

Course Objectives

- To model the digital logic using Verilog HDL
- To understand object-oriented programming concepts
- To understand the System Verilog verification environment

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Design digital logic using advanced Verilog HDL
2. Carry-out object-oriented programming concepts for verification environment
3. Implement the different system Verilog constraints and arrays
4. Construct the system Verilog verification environment
5. Analyze the different coverage types

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF SYSTEM VERILOG

Importance of System Verilog (SV), Difference between Verilog and SV, SV Data types: 2 State Data types (bit, byte, int, long_int, short_int), 4 State Data types (integer, real, real, time, logic, reg), User defined data types (Struct, enum, string, typedef)

UNIT II **9 Hours**

OBJECT ORIENTED PROGRAMMING AND METHODS

OOPs, Encapsulation, Polymorphism, Inheritance, Built-in Methods: Randomization, Pre & Post Randomize, Object Creation (new), User-Defined Methods: print method, copy methods (copy by handle, Shallow copy, Deep Copy)

UNIT III **9 Hours**

SV CONSTRAINTS AND ARRAYS

Simple Constraints, Weighted Distributed Constraint, Implication Operator Based Constraint, Variable Order Based Constraint, Static Array and Dynamic Arrays (Dynamic, Associative, and Queue Array)

UNIT IV **9 Hours**

INTER, PROCESS COMMUNICATION (IPC), INTERFACE AND COVERAGE

IPC, Semaphore, Mailbox, Events, Interface, Virtual Interface, Modport, Clocking Block, Coverage, Functional Coverage, Code Coverage, Cross Coverage, Coverage option

UNIT V **9 Hours**

SV VERIFICATION ENVIRONMENT

SV Verification Blocks, Generator Block: Bus Functional Model (BFM) Block, Interface Block, Monitor Block, Assertion Block, Environment Block, Program Block

Total: 45 Hours

Reference(s)

1. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003
2. Chris Spear and Greg Tumbush, SystemVerilog for Verification, Third Edition, Springer US ,2012
3. Stuart Sutherland, Simon Davidmann, Peter Flake, SystemVerilog for Design, Second Edition, Springer New York, NY,2006
4. https://verificationguide.com/systemverilog/systemverilog,tutorial/
5. https://www.chipverify.com/systemverilog/systemverilog,tutorial/

22EC019 ADVANCED DIGITAL SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To Learn fundamental concepts on Random variables and random process.
- To Analyze the concepts of multi rate signal processing and multi rate filters.
- To Design the optimum and adaptive filters for signal processing applications.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Apply the concept of random variables and random process in Discrete Time Signals
2. Apply the Multirate signal processing concepts in design of filter banks, subband coding
3. Analyze the design of LMS adaptive filters and its performance for non-stationary signals
4. Analyze the design of RLS adaptive filter and its variants.
5. Apply the concept of wiener filter in prediction and noise cancellation applications and analyze its performance.

Articulation Matrix

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

UNIT I **9 Hours**

DISCRETE TIME RANDOM PROCESS

Random variables- Ensemble Averages-Jointed distributed random variables- Independent, uncorrelated and orthogonal random Variables-Gaussian random variables- Random processes

UNIT II **9 Hours**

MULTIRATE SIGNAL PROCESSING

Introduction, decimation by a factor "D", Interpolation by a factor "I", sampling rate conversion by a factor "I/D", Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion.

UNIT III **9 Hours**

FIR ADAPTIVE FILTERS

The steepest Descent Adaptive Filter, The LMS Algorithm- Convergence of the LMS algorithm, Normalized LMS algorithm, LMS based adaptive filters, Gradient Adaptive Lattice filter

UNIT IV **9 Hours**

ADAPTIVE RECURSIVE FILTERS

Adaptive Recursive filters, Recursive Least square algorithm, Exponentially Weighted RLS, Sliding window RLS, Lattice recursive least squares filter (LRLS)

UNIT V **9 Hours**

WIENER FILTERS

The FIR Wiener Filter, -Linear Prediction, Noise cancellation, Lattice representation for the FIR wiener filter. The IIR wiener filter- Non-causal IIR wiener filter, The causal IIR wiener filter

Total: 45 Hours

Reference(s)

1. Ramrez, David, Ignacio Santamara, and Louis Scharf. Coherence: In Signal Processing and Machine Learning. Springer Nature, 2023.
2. H. MonsonHayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc., 2008.
3. G. John Proakis and G. Dimitris Manolakis, Digital Signal Processing, Pearson Education,2006.
4. P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education,2008.
5. N.J. Filege, Multirate Digital Signal Processing, John Wiley and Sons, 2000.
6. G. JohnProakis, Algorithms for Statistical Signal Processing, Pearson Education, 2002.

22EC020 SPEECH SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To study the basics of speech signal, speech production mechanisms
- To explore time domain and frequency domain analysis of speech signal
- To focus on the applications of speech signal processing

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Analyse the fundamentals and mechanism of speech signals
2. Apply time domain methods to extract the speech parameters
3. Apply and analyze frequency domain methods of speech processing
4. Apply and analyze the concepts of linear predictive analysis for speech processing
5. Apply the concepts of speech processing for various signal processing models

Articulation Matrix

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

UNIT I **9 Hours**

MECHANICS OF SPEECH

Speech production mechanism- Nature of Speech signal - Representation of Speech signals - Classification of Speech sounds - Phonetic and Phonemic alphabets - Articulatory features - Auditory perception

UNIT II **9 Hours**

TIME DOMAIN METHODS FOR SPEECH PROCESSING

Time domain parameters of Speech signal - Methods for extracting the parameters Energy- Average Magnitude - Zero crossing Rate - Silence Discrimination using ZCR and energy

UNIT III **9 Hours**

FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING

Short Time Fourier analysis - Filter bank analysis - Formant extraction - Pitch Extraction - Analysis by Synthesis- Phase vocoder - Channel vocoder -Formant and Pitch Estimation Speech enhancement

UNIT IV **9 Hours**

LINEAR PREDICTIVE ANALYSIS OF SPEECH

Formulation of Linear Prediction problem in Time Domain -Basic Principle - Auto correlation method - Covariance method - Solution of LPC equations - Durbin"s Recursive algorithm - Case study on analyzing customers" buying behavior in retail industries

UNIT V **9 Hours**

APPLICATION OF SPEECH SIGNAL PROCESSING

Algorithms: Spectral Estimation, dynamic time warping - Hidden Markov model - Pitch Detection - Feature analysis for recognition- Automatic Speech Recognition - Feature Extraction for ASR - Multi-language text-to-speech conversion

Total: 45 Hours

Reference(s)

1. Nilanjan Dey, Intelligent Speech Signal Processing, Elsevier Books Inc, 2019
2. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., 2004
3. Quatieri, Discrete-time Speech Signal Processing, Prentice Hall, 2001
4. L.R. Rabiner and R.W. Schaffer., Digital Processing of Speech signals, Prentice Hall, 1978
5. I.H. Witten, Principles of Computer Speech, Academic Press, 1982

22EC021 DIGITAL IMAGE PROCESSING 3 0 0 3

Course Objectives

- To study the digital image processing fundamentals.
- To understand the working of mathematical transforms applied on digital images.
- To acquire the basic knowledge in filters, image enhancement, image restoration and compression techniques.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Analyse the fundamentals of digital images and application of mathematical transforms on images.
2. Apply different methodologies for smoothening and sharpening of images in spatial and frequency domain.
3. Implement the segmentation techniques for the detection of edges, lines, and thresholding techniques.
4. Analyze the methods for image restoration and reconstruction using different filtering and projections.
5. Analyze different lossy and lossless coding techniques for image compression.

Articulation Matrix

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

UNIT I **9 Hours**

DIGITAL IMAGE FUNDAMENTALS

Fundamentals of digital image processing, Elements of visual perception, Image sampling and quantization, Basic Relationships between pixels. Image Transforms: Discrete Fourier transform, Cosine, Hadamard, Haar, Walsh and Slant transform

UNIT II **9 Hours**

IMAGE ANALYSIS

Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Frequency Domain: Image smoothing and sharpening using frequency domain filters.

UNIT III **9 Hours**

IMAGE SEGMENTATION

Edge detection: Point, line and edge detection- Detection of isolated points, Line detection, Edge models, Edge linking and boundary detection. Thresholding, Region splitting and Region Merging.

UNIT IV **9 Hours**

IMAGE RESTORATION AND RECONSTRUCTION

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Inverse filtering, Wiener Filtering, Geometric Mean Filter, Image reconstruction from projections.

UNIT V **9 Hours**

IMAGE COMPRESSION

Basic compression methods-Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-length coding, Block transform coding, Wavelet coding.

Total: 45 Hours

Reference(s)

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, 4th Edition, Pearson Education 2018.
2. Digital Image Processing, S. Jayaraman, S. Esakkirajan, T. Veerakumar, McGraw Hill Education, 2009. Pvt Ltd, NewDelhi.
3. S Sridhar, Digital Image Processing, 2nd ed., Oxford University Press, 2016.
4. Tinku Acharya and Ajoy K. Ray-Image Processing Principles and Applications, A John Wiley & Sons, Mc., Publication 2005.
5. Ardeshir Goshtasby, 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications, John Wiley and Sons, 2005.

22EC022 MULTIMEDIA COMPRESSION TECHNIQUES

3 0 0 3

Course Objectives

- To Understand the special features and representations of different data types.
- To Analyze different compression techniques for text data and audio signals
- To Analyze various compression techniques for image and video signals

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Apply the fundamental concepts of multimedia and compression techniques.
2. Implement different lossy and lossless coding techniques for text compression.
3. Analyze the various lossy and lossless coding techniques for audio compression.
4. Apply and analyze the compression techniques for images.
5. Analyze different video compression standards and techniques.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Text, Images, Graphics, Video and Digital Audio - Storage requirements for multimedia applications - Need for Compression - Lossy & Lossless compression techniques

UNIT II **9 Hours**

TEXT COMPRESSION

Compression techniques - Huffmann coding - Adaptive Huffmann Coding - Arithmetic coding - Shannon- Fano coding - Dictionary techniques - LZ77, LZ78, LZW family algorithms.

UNIT III **9 Hours**

AUDIO COMPRESSION

Audio compression techniques-MU-Law and A-Law companding - Frequency domain and filtering - Basic sub- band coding -DPC M-ADPCM-DM-LPC-CELP -Application to speech coding - G.722 - Application to audio coding - MPEG audio

UNIT IV **9 Hours**

IMAGE COMPRESSION

MMR coding - Transform Coding - JPEG Standard - Sub-band coding algorithms - Design of Filter banks - Wavelet based compression - Implementation using filters - EZW, SPIHT coders - JPEG 2000 standards - Run length coding.

UNIT V **9 Hours**

VIDEO COMPRESSION

Video compression techniques and standards - MPEG Video Coding I: MPEG-1 and 2 - MPEG Video Coding II - MPEG - 4 and 7 - Motion estimation and compensation techniques - H.261 Standard

Total: 45 Hours

Reference(s)

1. David Salomon, Data Compression, The Complete Reference, Springer Verlang, 2006
2. Colt McAnlis, Understanding Compression, O""Reilly Media, Inc,2016
3. Khalid Sayood, Introduction to Data Compression, Morgan Kauffman Harcourt India, 2007.
4. Yun Q. Shi and Huifang Sun, Image and Video Compression for Multimedia Engineering. Fundamentals, Algorithms& Standards, CRC press, 2003.
5. Peter Symes, Digital Video Compression, McGraw Hill Publication, 2004.
6. Mark S. Drew and Ze-Nian Li, Fundamentals of Multimedia, PHI, 2003.

22EC023 COMPUTER VISION 3 0 0 3

Course Objectives

- To Learn the image fundamentals and mathematical transforms necessary for image processing
- To Understand the image enhancement and restoration methods
- To Study the concepts of optics and lens systems

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Apply the various image enhancement and segmentation methods
2. Carry-out the different morphological operations and shape representations in digital images
3. Differentiate of different techniques in object recognition systems
4. Analyze the different camera systems for 3D vision tasks
5. Analyze the various motion methods in processing of machine vision images

Articulation Matrix

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

UNIT I **9 Hours**

IMAGE SEGMENTATION

Thresholding - Edge based segmentation - Region based segmentation - Matching - Evaluation issues in segmentation - Mean Shift segmentation - Active contour models - snakes - Geometric deformable models - level sets and geodesic active contours - Fuzzy Connectivity

UNIT II **9 Hours**

MORPHOLOGY AND SHAPE REPRESENTATION

Basic morphological concepts - Four morphological principles - Binary dilation and erosion-Gray scale dilation and erosion -Skeletons and object marking - Granulometry - Morphological segmentation and watersheds. Region identification

UNIT III **9 Hours**

OBJECT RECOGNITION

Knowledge representation - Statistical pattern recognition - Neural nets - Syntactic pattern recognition - Recognition as graph matching - Optimization techniques in recognition - Fuzzy systems - Boosting in pattern recognition

UNIT IV **9 Hours**

3D VISION

3D vision tasks - Basics of projective geometry - A single perspective camera-Scene reconstruction from multiple views -Two cameras, stereopsis - Three cameras and trifocal tensor- 3D information from radiometric measurements

UNIT V **9 Hours**

MOTION ANALYSIS

Differential motion analysis methods - Optical flow - Analysis based on correspondence of interest points - Detection of specific motion patterns - Video tracking - Motion models to aid tracking

Total: 45 Hours

Reference(s)

1. Ramesh Jain, Rangachar Kasturi and Brian G. Schunck, Machine Vision, McGraw Hill International Edition, 2012
2. Sonka, Hlavac, Boyle, Image Processing, Analysis and Machine Vision, CENGAGE Learning, 4th Edition, 2015
3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson India, 3rdEdition, 2013
4. W.K. Pratt, Digital Image Processing, John Wiley and Sons, 2001

22EC024 WAVELET TRANSFORMS AND APPLICATIONS — 3 0 0 3

Course Objectives

- To understand the basic concept of wavelet transforms.
- To apply the wavelet transforms in the dynamic system models and classifiers.
- To apply wavelet signal processing techniques in domains of signal and image processing techniques.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Apply the fundamentals of continuous and discrete wavelet transforms.
2. Implement the orthonormal basis and filter banks of wavelet transform.
3. Apply and analyze biorthogonal wavelet bases and 2D wavelet packets.
4. Apply and analyze wavelet transform in signal and image models.
5. Outline the recent advancements of wavelet transform in signal and image processing application.

Articulation Matrix

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

UNIT I **9 Hours**

CONTINUOUS AND DISCRETE WAVELET TRANSFORM

Concepts of continuous time wavelet transform, CWT as a correlation, Constant Q factor filtering-interpretation, time frequency resolution, CWT as an operator, inverse CWT, Discrete wavelet transform

UNIT II **9 Hours**

ORTHONORMAL WAVELETS AND FILTER BANKS

Definition of MRA, Construction of a general orthonormal MRA, Wavelet basis for MRA, Digital filtering, Examples of orthonormal basis, generating wavelets, Interpreting orthonormal MRA for discrete, time signals

UNIT III **9 Hours**

ALTERNATIVE WAVELET TRANSFORMS

Biorthogonal wavelet bases, Filtering relations for orthogonal filters, examples of biorthogonal scaling fuctions and wavelets, 2D Wavelets, non separable multidimensional wavelets, Wavelet packets, transform coding

UNIT IV **9 Hours**

APPLICATION OF WAVELET TRANSFORMS

Wavelet denoising, speckle removing, Edge detection and object isolation, image fusion, Object detection by wavelet transforms of projections, communication applications, Scaling functions as signaling pulses

UNIT V **9 Hours**

ADVANCED TOPICS

Parsevals identity for CWT, wavelet inner product as a projection operation, CWT with an orthonormal basis for generating wavelet, ATrous algorithm, regularity, convergence, Daubechies construction of orthonormal scaling functions, band limited biorthogonal decomposition.

Total: 45 Hours

Reference(s)

1. Lokenath Debnath, Firdous Ahmad Shah, Wavelet Transforms and Their Applications, BirkhÃƒÂ¤user Boston Inc, 2014
2. Mallat., Wavelet Tour of Signal Processing, Academic Press, 2008.
3. Raghuveer.M. Rao and Ajit.S. Bopardikar, Wavelet transforms Introduction to theory and Applications, Addison Wesley education Asia 2000.
4. C.Sidney burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to wavelets and wavelet transforms A Primer, PH International Editions,1998.
5. G. Strang and T. Nguyen, Wavelets and Filter Banks, Wellesley Cambridge Press, 1996

22EC025 UNDERWATER ACOUSTIC COMMUNICATIONS

3 0 0 3

Course Objectives

- Learn the characteristics of Underwater Acoustic environment.
- To be able to analyze and design the performance of underwater acoustic systems
- Detection of active signal, estimation of time of arrival and signal magnitude to asses geometric properties of underwater channel and to asses emission level and target strength.
- Design the Optimization techniques in Echo cancellation, Beam forming and Noise reduction methods.
- Understand the concepts of acoustic signal models.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Find the characteristics of underwater acoustic channel environment.
2. Analyze the principles and characteristics of SONAR systems.
3. Analyze and develop acoustic an echo cancellation algorithm and beamforming techniques.
4. Analyze the challenges in noise reduction in underwater environment.
5. Analyze the acoustic MIMO system design for underwater scenario.

Articulation Matrix

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

UNIT I **7 Hours**

FUNDAMENTAL OF UNDERWATER ACOUSTICS

Speed of sound in seawater - Transmission Loss - Refraction - Deep sound channel and Reliable acoustic path - Surface Interference - Active and Passive UWSN - Noise and Bandwidth Considerations.

UNIT II **11 Hours**

SONAR SYSTEMS

SONAR equations: Active and Passive, Underwater sound systems: Generic Active SONAR systems and Generic Passive SONAR systems, SONAR Transducers, Receivers, Receiving arrays and sonobuoys - Signal processing functions.

UNIT III **10 Hours**

ECHO CANCELLATION AND BEAM FORMING TECHNIQUES

Acoustic echo cancellation (AEC) - Adaptive Beam Forming - Joint Acoustic echo cancellation and Adaptive Beamforming - Optimization Techniques: LCLSE, GSC, GSAEC, and RGSC Methods.

UNIT IV **10 Hours**

NOISE REDUCTION

Weiner Filter and spectral subtraction - Optimum Filter design in the digital domain - Weiner filter in the frequency domain - Weiner filter realizations - Spectral subtraction: Principles and realizations.

UNIT V **7 Hours**

ACOUSTIC MIMO SYSTEMS

Acoustic environment distraction - Signal Models: SISO, SIMO, MISO, and MIMO - Characteristics: Reverberation Time - Channel Invertibility and Minimum phase filter - Multichannel diversity and Common Zero problem - Spare Impulse response.

Total: 45 Hours

Reference(s)

1. Stergiopoulos, Stergios- Advanced signal processing handbook_theory and implementation for radar, sonar, and medical imaging real time systems-CR (2017).
2. David Havelock, Sonoko Kuwano, Michael Vorlander-Handbook of Signal Processing in Acoustics (2 vol set) - Springer (2009).
3. Jens Blauert, Ning Xiang-Acoustic MIMO Signal Processing-Springer (2006).
4. E. Hansler, G. Shmidt -Topics in Acoustic Echo and Noise Control-Springer (2006)
5. Hanzo L., Somerville F.S., Woodard J.-Acoustic Signal Processing for Telecommunication, (2002).
6. L.Kinsler, et al., Fundamentals of Acoustics, Wiley Publications, (2000) - Fourth edition.

22EC026 SATELLITE COMMUNICATION 3 0 0 3

Course Objectives

- To know the basics of satellite communication
- To understand the concepts of orbital mechanics, multiple access techniques and space links
- To gain knowledge on spacecraft subsystems, earth stations and satellite platform applications

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Apply Orbital effects in Communication System and analyze performance of Attitude control
2. Analyze the various subsystems of spacecraft
3. Design and analyze the characteristics of satellite links
4. Analyze various multiple access techniques in a satellite network
5. Compare different types of satellite services in broadcasting multimedia applications

Articulation Matrix

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

UNIT I **9 Hours**

ORBITAL MECHANICS

Kepler's laws of motion, Orbits, Orbit Equations, Orbit Description, Locating the Satellite in the Orbit and with Respect to Earth, Orbital Elements-Look Angle Determination and Visibility - Orbital Perturbations, Orbit Determination, Launch Vehicles, Spectrum allocations for satellite systems.

UNIT II **9 Hours**

SPACECRAFT SUB SYSTEMS AND EARTH STATION

Spacecraft Subsystems, Altitude and Orbit Control, Telemetry and Tracking, Power Systems, Communication Subsystems - Transponders, Antennas, Amplifier, Amplifier Noise Temperature, Equipment Reliability.

UNIT III **9 Hours**

SPACE LINKS

Satellite Link Design - Satellite uplink and down link power Budget, Basic Transmission Theory, System Noise Temp, G/T Ratio, Noise Figure, Interference between satellite circuits, Energy Dispersal, propagation characteristics of fixed and mobile satellite links.

UNIT IV **9 Hours**

MULTIPLE ACCESS TECHNIQUES AND NETWORK ASPECTS

Multiple access (MA). Classical MA techniques: FDMA, TDMA, CDMA, DAMA. Mobile satellite network design, ATM via satellite. TCP/IP via satellite - Call control, handover and call set up procedures. Hybrid satellite-terrestrial networks.

UNIT V **9 Hours**

SERVICES AND APPLICATIONS

INTELSAT series, INSAT, VSAT, Remote Sensing - Mobile satellite service: GSM, GPS, INMARSAT, LEO, MEO, Navigation System, Direct to Home service (DTH), Digital Audio Broadcast (DAB), Special Services-E-mail, Video conferencing and Internet connectivity.

Total: 45 Hours

Reference(s)

1. Dennis Roddy, Satellite Communications, Fourth Edition, Mc Graw Hill International Editions, 2006.
2. Bruce R. Elbert, The Satellite Communication Applications Hand Book, Artech House Boston, Second Edition, 2004.
3. Wilbur L. Pritchard, Hendri G. Suyderhood, Robert A. Nelson, Satellite Communication Systems Engineering, Second Edition, Prentice Hall, New Jersey, 1993.
4. Louis J. Ippolito, Jr., Satellite Communications Systems Engineering - Atmospheric Effects, Satellite Link Design and System Performance, First edition, John Wiley & Sons Ltd., 2008.
5. Tri T. Ha, Digital satellite communication, 2nd Edition, McGraw Hill, New York, 1990
6. Peter Teunissen, Springer Handbook of Global Navigation Satellite Systems, Springer Handbooks, ISBN: 9783030731724, July 25th, 2021.

22EC027 OPTICAL COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- Awareness on phenomena involved light propagation through various fiber configurations and the issues like attenuation mechanisms (losses) and signal degradation (dispersion effects)
- Characteristics of different components like transmitters, receivers, coupler etc., and their suitability to different types of optical communication links.
- Determination of choice of components for deployment of a given optical link based on link power (losses) & rise time (dispersive) budget and managing the optical network.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO6 Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Implement the behavior of different optical medium (fibers) and performance of signal Propagation.
2. Demonstrate the issues in propagation of optical signals resulting from signal degradation mechanism of optical fiber media.
3. Analyze the performance of optical sources, detectors and the concept for choice of light sources, detectors for the given optical link
4. Demonstrate the working of optical components in the design of optical networks. optical links.
5. Analyse the power loss and signal dispersive nature of optical media and apply the result to identify appropriate transmitter, receiver, on line.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO OPTICAL FIBERS

Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations. Mode theory of Circular Waveguides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes Single-Mode Fibers

UNIT II **9 Hours**

SIGNAL DEGRADATION OPTICAL FIBERS

Attenuation, Absorption losses, scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Waveguides-Information Capacity determination. Group Delay-Material Dispersion, Waveguide Dispersion, Polarization Mode dispersion, Intermodal dispersion, Mode Coupling

UNIT III **9 Hours**

FIBER OPTICAL SOURCES AND DETECTORS

Direct and indirect Band gap materials -LED- lasers Diodes - Quantum efficiency-PIN and APD diodes-Photo detector noises, SNR, Detector Response time, Comparison of Photo detectors.

UNIT IV **9 Hours**

OPTICAL NETWORK COMPONENTS

Couplers, Isolators, Switches, Wavelength Converters, Circulators, Filters, Multiplexers, WDM, Optical Amplifiers-EDFA - Basic on concepts of SONET/SDH Network

UNIT V **9 Hours**

SYSTEM DESIGN AND MANAGEMENT

Point to Point links System considerations, Power budget, time budget- bandwidth budget calculations, Noise Effects on System Performance- OTDR -Attenuation and dispersion, Field Measurements. Network Management- Performance and fault management, Configuration Management.

Total: 45 Hours

Reference(s)

1. Optical Fiber Communication by Gerd Keiser, Springer Nature Singapore, March 2021
2. Optical Networks: A Practical Perspective by Rajiv Ramaswami and Kumar Sivarajan Morgan Kaufmann, 2010.
3. Optical Communication, Principles and Practice by J. Senior Prentice Hall of India, third edition published 2009.
4. Optical Communication-Components and Systems by J.H. Franz, V.K. Jain, Narosa Publishing House, 2000.
5. Optical Network Design and Implementation by Vivek Alwayn, Pearson Education, 2006.
6. Optical Networks: Architecture and Survivability by Hussein T. Mouftab and Pin-Han Ho, Springer US, 2003

22EC028 MIMO COMMUNICATION 3 0 0 3

Course Objectives

- To learn the concepts of MIMO channel propagation and MIMO channel model.
- To understand spatial diversity and MIMO channel capacity performance in wireless communication.
- To provide the fundamental knowledge on Space-Time Codes and MIMO detection techniques.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO6 Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application-oriented engineering systems.

Course Outcomes (COs)

1. Analyze the channel models and power allocation in MIMO Systems.
2. Apply the mathematics concepts and Calculate the capacity of deterministic and random MIMO channels and fading channels
3. Analyze the implication of spatial diversity method and calculate the diversity order and channel variability.
4. Analyze the concept of different space time coding techniques like STBCs, STTCs and Space time turbo codes
5. Analyze the various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MIMO CHANNEL MODELS

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation

UNIT II **9 Hours**

MIMO CHANNEL CAPACITY

Capacity for deterministic MIMO Channels: SISO, SIMO, MISO, MIMO, Capacity of random MIMO channels: SISO, SIMO, MISO, MIMO (Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel

UNIT III **9 Hours**

SPATIAL DIVERSITY

Diversity gain, receive antenna diversity, transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, combined space and path diversity, Indirect transmit diversity, Diversity of a space, time, frequency selective fading channel.

UNIT IV **9 Hours**

SPACE-TIME CODES

Advantages, code design criteria, Alamouti space time codes, SER analysis of Alamouti space-time code over fading channels, Space time block codes, Space time trellis codes, Performance analysis of Space, time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST, HBLAST, SCBLAST, DBLAST

UNIT V **9 Hours**

MIMO DETECTION TECHNIQUES

Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection

Total: 45 Hours

Reference(s)

1. TolgaM.Duman and Ali Ghrayeb, Coding for MIMO Communication Systems, John Wiley & Sons Ltd.,2007
2. 2. EzioBiglieri, Robert Calderbank and Anthony Constantinides. MIMO Wireless Communications Cambridge University Press, 2007
3. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.
4. B. Kumbhani and R. S. Kshetrimayum, MIMO Wireless Communications over Generalized Fading Channels, CRC Press, 2017
5. T. L. Marze_a, E. G. Larsson, H. Yang and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016.

22EC029 SIGNAL PROCESSING FOR MM WAVE COMMUNICATION

3 0 0 3

Course Objectives

- To impart the knowledge and encompasses the complete mmWave communication from the signal processing point of view.
- To give an in-depth knowledge about the mmWave channel models.
- To analyze the MIMO-OFDM in mmWave channel models.
- To design and analyze the beamforming technology of the mmWave models.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the ray tracing channel models in narrowband and wideband aspects.
2. Analyze the various time varying channel model
3. Analyze the mmWave channel model using Transmitter and receiver side multiple antennas
4. Design and analysis of various beamforming techniques in mmWave channel model.
5. Analyze the Precoder, Phase Shifter, Equalizer for better optimization of design parameters.

Articulation Matrix

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

UNIT I **9 Hours**

AN INTRODUCTION TO WIRELESS CHANNELS

Wireless Channel - A ray tracing model - Fundamentals and General Channel Model - RMS Delay, and Doppler effect of the channels, Understanding of various channel-related parameter statistics - Narrowband and broadband aspect.

UNIT II **9 Hours**

TIME VARYING CHANNEL MODEL

Time-varying model - Doppler impact of coherence Bandwidth - AR, ARMA and MA process - Doppler with AR process - Coherence Time and parameters

UNIT III **9 Hours**

MMWAVE CHANNEL MODEL

Basics of ISI channel - Channel estimation and Equalizer -Precoder and MIMO channel - mmWave Spectrum - 3D Concepts: AOA - AOD - mmWave Channel Model: mmWave channel model with Rx Beamforming - Channel Model: Tx with multiple antennas.

UNIT IV **9 Hours**

BEAMFORMING TECHNIQUES

Single antenna Beamforming - Different geometry of antenna from an electrical point of view - Basics of Beamforming pattern - SISO Beamforming - Concept of antenna many fold vector, beam parameters, efficiency of beams pattern.

UNIT V **9 Hours**

HYBRID BEAMFORMING TECHNIQUES

Hybrid Beamforming of mmWave MIMO systems: Precoder, Phase Shifter, Equalizer, Optimization of design parameters, MIMO-OFDM, parameter estimation using LMMSE - mmWave system impairments.

Total: 45 Hours

Reference(s)

1. Kao-Cheng Huang, Zhaocheng Wang, Millimeter Wave Communication Systems, 1st edition, Wiley-IEEE Press, 2011
2. David Tse, Pramod Viswanath, Fundamentals of wireless communication, Cambridge University Press, 2003.

22EC030 MACHINE LEARNING FOR WIRELESS COMMUNICATIONS

3 0 0 3

Course Objectives

- To understand the principles of machine learning and apply the fundamental principles for regression and classification.
- To apply the mathematical principles of probability, linear algebra and optimisation
- To apply machine learning principles in the design of some physical layer techniques in wireless communications

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Apply the principles of machine learning and apply the fundamental principles for regression and classification.
2. Apply the linear Modeling approach for estimation of the signal.
3. Apply the Bayesian Approach to Machine Learning for channel estimation.
4. Apply the machine learning concept for clustering and classification.
5. Analyze different Machine learning algorithms for wireless applications.

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS OF MACHINE LEARNING

Quick overview of Supervised, Unsupervised and Reinforcement Learning- Supervised Learning-Classification, Neural networks and Deep Learning, Unsupervised Learning-Clustering, Autoencoders, Reinforcement Learning-Markov Decision Processes, Q-Learning o Multi-armed Bandits

UNIT II **9 Hours**

LINEAR MODELING

A Least Squares Approach, Linear modelling, Generalization and over fitting, Regularized least squares A Maximum Likelihood Approach, Errors as noise, Maximum likelihood, Bias-variance trade-off, Effect of noise on parameter estimates.

UNIT III **9 Hours**

BAYESIAN APPROACH

Exact posterior, Marginal likelihood, Hyperparameters, Bayesian Inference- Non-conjugate models, Point estimate, MAP solution, Laplace approximation

UNIT IV **9 Hours**

CLUSTERING AND CLASSIFICATION

Classification: Probabilistic classifiers, Bayes classifier, logistic regression, Non Probabilistic classifiers, K-nearest neighbors, Discriminative and generative classifiers Clustering: General Problem, K-means clustering, Gaussian mixture models (GMM),EM algorithm , MAP estimates, Bayesian mixture models.

UNIT V **9 Hours**

APPLICATION IN WIRELESS

Physical layer communications, Use of autoencoders, Modulation, Channel coding, Modulation / Signal classification, Localization, Spectrum Sensing, Adaptive modulation and coding (AMC): classical AMC, using support vector machines, using k-nearest neighbors, using k-means, using reinforcement learning.

Total: 45 Hours

Reference(s)

1. M. Bishop Pattern Recognition and Machine Learning, Christopher, Springer 2009.
2. P Murphy, MIT Machine Learning a Probabilistic Perspective, Kevin Press 2012
3. Machine Learning and Wireless Communications, Yonina C. Eldar, Princeton University, New Jersey, Cambridge University Press, June 2022.

22EC031 MICROWAVE CIRCUITS AND SYSTEMS 3 0 0 3

Course Objectives

- To describe the basic principles and advanced applications of Microwave Engineering.
- To introduce the concept of transmission lines and waveguides.
- To illustrate the concepts of microwave network analysis and impedance matching.
- To learn about various types of resonators.
- To learn about Microwave Filters.
- To describe the procedures to design different amplifiers, oscillators and mixers.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Apply the concept and derive different characteristics of various transmission lines waveguides
2. Analyze various parameters of microwave networks.
3. Analyze and design microwave filters and resonators
4. Analyze the concept of amplifier stability, gain and noise figure
5. Analyze EMI/EMC for all microwave small signal and power amplifiers

Articulation Matrix

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

UNIT I **9 Hours**

RF AND MICROWAVE PASSIVE COMPONENTS

Resistor Inductor and Capacitor at High Frequency Directional Couplers Two-hole directional couplers Isolator Circulator S Matrix for microwave components

UNIT II **11 Hours**

MICROWAVE NETWORK ANALYSIS AND TUNING

Impedance and admittance matrices, scattering matrices, ABCD matrix, Signal flow graphs, discontinuities and modal analysis, Series and parallel resonance circuits, transmission line resonators rectangular waveguide cavity resonator, circular waveguide cavity resonator, dielectric resonator.

UNIT III **9 Hours**

MICROWAVE FILTERS

Periodic structures, filter design by: Image parameter method, insertion loss method, filter transformation, filter implementation, LPF, coupled line filters, filters using coupled resonators.

UNIT IV **9 Hours**

MICROWAVE AMPLIFIER, OSCILLATOR AND MIXER DESIGN

Two port power gains, single stage transistor amplifier design, broadband transistor amplifier design, power amplifier, RF oscillators Microwave Oscillator, oscillator phase noise, frequency multipliers, and mixers.

UNIT V **7 Hours**

MODERN TRENDS IN MICROWAVES ENGINEERING

Effect of Microwaves on human body. Medical and Civil applications of microwaves. Electromagnetic interference Electromagnetic Compatibility (EMI EMC).

Total: 45 Hours

Reference(s)

1. R.E. Collin, Foundations of Microwave Engineering, Wiley, 2nd edition 2007.
2. Ramo, Whinnery and Van Duzer, Fields and Waves in Communication Electronics, 3rd Edition, Wiley, 2007.
3. David. M Pozar, Microwave and RF System Design, Wiley 2001.
4. Wayne Tomasi, Advanced Microwave Communication Systems, PHI, 2nd Edition, 2002

22EC032 MICROWAVE INTEGRATED CIRCUITS 3 0 0 3

Course Objectives

- To acquire an insight view and knowledge to design different types of resonators, filters and advanced microwave structures.
- To gain proficiency regarding microwave integrated circuit concepts and relation between different parameters.
- To analyse and design microwave integrated circuit design using lumped elements and transmission lines.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Apply the concept of production methods, substrates, packaging and components in Monolithic MIC technology.
2. Analyze and design the different types of microwave integrated circuits by using transmission lines and lumped elements.
3. Analyze different types of resonators and filters to select frequencies in microwave communication circuit.
4. Analyze the various measurement techniques involved in Microwave Integrated Circuits.
5. Analyze the design and development of advanced microwave structures to enable the current MIC technologies in near future.

Articulation Matrix

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

UNIT I **9 Hours**

MONOLITHIC MIC TECHNOLOGY

Introduction to microwave communication and EM spectrum Characteristics of Microwave and Millimeter waves MMIC technology, Applications, Substrates, Production Methods, Packaging, and Electrical Connections, Components for Integrated Microwave Circuits.

UNIT II **9 Hours**

TRANSMISSION LINES AND LUMPED ELEMENTS

Characteristics of Planar Transmission lines Strip line, Microstrip, Suspended and Inverted Microstrip Lines, Coupled Lines and its Discontinuities Lumped elements: Design of Lumped elements, Inductors, Capacitors, and Resistors.

UNIT III **9 Hours**

FILTERS AND RESONATORS

Introduction Resonator parameters Planar Microstrip resonant structures Dielectric resonator. Filter Synthesis: Low pass filter, Special response filter, Filter transformations, Impedance and Admittance Inverters Filter Modelling: Narrowband approximation, Filter Realizations Dielectric Resonant Filters Practical considerations.

UNIT IV **9 Hours**

MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES

Microwave Integrated Circuits MIC Materials Hybrid versus Monolithic MICs Multichip Module Technology Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements.

UNIT V **9 Hours**

ADVANCED MICROWAVE STRUCTURES

Defect Ground Structure Introduction, Base structure, Circuit topologies, Characteristics, Modelling of DGS and Application of DGS Substrate Integrated Waveguides: Introduction Geometry Operation Principle Analysis Techniques of SIW Design Considerations.

Total: 45 Hours

Reference(s)

1. David M. Pozar, Microwave Engineering, John Wiley & Sons, 1998.
2. David M. Pozar, Microwave & RF Design of Wireless Systems, John Wiley & Sons, 1998.
3. Ramesh Garg, InderBahl, Maurizio Bozzi Microstrip Lines and Slotlines, Third Edition Artech House (2013).
4. Ulrich L. Rohde, Matthias Rudolph RF/Microwave Circuit Design for Wireless Applications Wiley (2012).
5. InderBahl, Prakash Bhartia Microwave Solid State Circuit Design-Wiley Interscience (2003).
6. Hoffman R.K, Handbook of Microwave Integrated Circuit, Artech House (1987).

22EC033 RF SYSTEM DESIGN **3 0 0 3**

Course Objectives

- To identify the and realize the different specification parameters of a wireless system.
- To analyze the characteristics of noise and distortion in wireless RF systems.
- To design RF systems using behavior models of the subsystems present in the receiver chains.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the characteristics of noise and distortion in the microwave systems due to temperature, mismatched terminations and inter-modulations.
2. Design and implement the Filters using image impedance, insertion loss and prototype techniques.
3. Analyze the performance of amplifier circuits in the receivers in different configuration modes.
4. Design the different mixer circuits using Schottky barrier diode, FETs and analyze its characteristics.
5. Analyze the devices for switches, oscillator circuits, frequency synthesizers and evaluate its performance at the receiver end.

Articulation Matrix

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

UNIT I **9 Hours**

NOISE AND DISTORTION IN RF SYSTEMS

Noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, mismatched transmission lines and Wilkinson power dividers; Dynamic range and inter-modulation distortion.

UNIT II **9 Hours**

RF FILTER DESIGN

RF filter design-constant K prototype filter design-derived prototype filter design. Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation.

UNIT III **9 Hours**

RF AMPLIFIER DESIGN

Circuit models for FETs and BJTs; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain, low-noise amplifier design, design of class-A power amplifiers.

UNIT IV **9 Hours**

MIXERS

Mixer characteristics: Image frequency, conversion loss, noise figure; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.

UNIT V **9 Hours**

SWITCHES

Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches.

Total: 45 Hours

Reference(s)

1. Pozar, D.M. Microwave and RF Design of Wireless Systems, John Wiley & Sons.
2. Gonzalez, G., Microwave Transistor Amplifiers: Analysis and Design, 2nd Ed., Prentice-Hall. 1997.
3. Bahl, I. and Bhartia, P., Microwave Solid State Circuit Design, 2nd Ed., John Wiley & Sons. 2003.
4. Chang, K., Bahl, I. and Nair, V., RF and Microwave Circuit and Component Design for Wireless Systems, Wiley Interscience. 2002.
5. Rohde, U.L. and Newkirk, D.P., RF/Microwave Circuit Design for Wireless Applications, John Wiley & Sons. 2000.
6. Larson, L.E., RF and Microwave Circuit Design for Wireless Applications, Artech House. 1996.

22EC034 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

Course Objectives

- To apply, identify and understand the basic sources of EMI & EMC.
- To formulate and analyze different EMI measurements.
- To understand the concepts of EMI control mechanisms which meets the specific needs with appropriate techniques.
- To select, apply and differentiate appropriate standards for EMI/EMC
- To design, analyze and understand the process of creating EMC PCBs

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Analyze the effects of EMI-EMC and their sources of origination
2. Design and implement the EMI rejection filters for a particular application.
3. Apply EMI control mechanisms for specific needs with appropriate techniques
4. Compare and discuss about different standards for EMI/EMC.
5. Design and analyze the process of creating EMC PCBs

Articulation Matrix

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

UNIT I **9 Hours**

EMI ENVIRONMENT

Concepts of EMI and EMC and definitions Sources of EMI Celestial Electromagnetic noise Lightning Discharge-Electrostatic Discharge Electromagnetic Pulse Electromagnetic emissions Noise from relays and Switches Nonlinearities in Circuits.

UNIT II **9 Hours**

EMI COUPLING PRINCIPLES

Capacitive coupling Inductive coupling Common impedance ground coupling- Ground loop coupling Transients in power supply lines Radiation coupling, Conduction coupling Common mode and Differential mode interferences Conducted EM noise on power supply lines.

UNIT III **9 Hours**

EMI MEASUREMENTS

Open area test site measurements Measurement precautions Open -area test site Anechoic Chamber TEM Reverberating TEM GTEM cell Comparisons

UNIT IV **9 Hours**

EMI CONTROL TECHNIQUES

EMC Technology Grounding-Shielding Electrical Bonding Power line filter CM filter DM filter EMI suppression Cables EMC Connectors Isolation transformer.

UNIT V **9 Hours**

EMI/EMC STANDARDS

Introduction Standards for EMI/EMC MIL STD 461/462-IEEE/ANSI standard CISPR/IEC standard FCC regulations British standards VDE standards Euro norms Performance standards Comparisons.

Total: 45 Hours

Reference(s)

1. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE Press, 2 nd edition 2011.
2. C.R. Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, Inc, 2 nd edition 2010.
3. Henry W. Ott, Electromagnetic Compatibility Engineering, John Wiley and Sons, New York, 2009.
4. Clayton R. Paul, Introduction to Electromagnetic Compatibility, 2nd Edition, wiley publishers, 2006.

22EC035 ANTENNA TECHNOLOGIES FOR WIRELESS APPLICATIONS 3 0 0 3

Course Objectives

- To understand the fundamental knowledge on evolution of wireless communications
- To analyze the performance of the antenna for nearfield and indoor Applications
- To design the antenna for cellular applications

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO7 Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the requirements of an antenna for wireless applications with respect to its parameters
2. Analyze the radiation pattern of antennas using EM CAD simulator software-ADS
3. Design the antennas for typical applications including RFID, Zigbee, cellular, wearable devices and UWB communication
4. Design an electrically small antennas using design principles
5. Analyze the challenges associated with the deployment and implementation of 5G networks

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO WIRELESS SYSTEMS AND STANDARDS

Wireless systems and standards – Applications, Air interface- Near field, Indoor, Outdoor, Requirements of antenna for above applications, Base station (BS) and User equipment (UE) antennas

UNIT II **9 Hours**

NEAR FIELD APPLICATIONS

Reader antennas- Specifications- gain, bandwidth and polarization, pillar antennas and design. RFID Tag Antennas: Tag architecture- Tag, clip type, Types of Tag, Radio Link, Parameters, Effect of Environment on RFID Tag Antennas. Design of reader and tag antennas.

UNIT III **9 Hours**

ANTENNAS FOR INDOOR APPLICATIONS

Zigbee and WLAN: air interface, frequency, Bandwidth and data rate requirement. Specification & topologies, Antennas for Zigbee/WLAN Access points- whip antennas, diversity. Antennas for user equipment- design challenges- gain, efficiency, SAR and size constraints.

UNIT IV **9 Hours**

CELLULAR ANTENNAS

Cellular applications, Performance Requirements, Mode of operation, Base station antenna-specifications and challenges, topologies, Electrically Small Antennas, Topologies- Patch arrays, Beam tilting, null fill.

UNIT V **9 Hours**

ANTENNAS FOR NEXT GENERATION WIRELESS APPLICATIONS

4G & 5G communication, challenges, form factor and broadband performance, Conformal, wearable antennas for body area network and UWB antennas.

Total: 45 Hours

Reference(s)

1. Zhi Ning Chen, Antennas for Portable devices Wiley Publishers, 2007
2. R. Waterhouse Printed antennas for wireless communications John Wiley Publishers
3. Peter S. Hall, Yang Hao Antennas and propagation for body-centric wireless communications
4. J.C. Liberti, JR and Theodore Rappaport, Smart Antennas for Wireless communication, Prentice Hall of India, 1999.
5. Grishkumar and K.P. Ray, Broadband microstrip antennas Artech House, 2003
6. John D.Kraus, Ronald J.Marhefka Antennas for all Applications Fourth Edition, Tata McGraw-Hill, 2006.

22EC036 SMART ANTENNAS 3 0 0 3

Course Objectives

- To Understand the fundamental knowledge on smart antenna systems and its configuration
- To estimate the Direction of arrival and using appropriate techniques.
- To simulate and measure the performance of the antenna structures using software tools

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO7 Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the architecture of smart antenna systems and its configuration to meet the requirements of real time applications
2. Apply the adaptive antenna systems and digital radio receiver techniques for smart antennas.
3. Analyze and evaluate the range and capacity of wireless systems equipped with smart antennas
4. Analyze the direction of arrival of the signal from the smart antenna array using appropriate methodologies
5. Design the smart antennas using simulation tools and to evaluate its performance with vector network analyser

Articulation Matrix

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

UNIT I **9 Hours**

SMART ANTENNAS

Spatial Processing for Wireless Systems, Key Benefits of Smart Antennas, smart antenna configuration, SDMA, architecture of smart antenna systems.

UNIT II **9 Hours**

SMART ANTENNA SYSTEMS AND SPATIAL SIGNAL PROCESSING

The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming Networks, Switched Beam Systems, Adaptive Antenna Systems, Digital Radio Receiver Techniques and Software Radios for Smart Antennas

UNIT III **9 Hours**

MULTI-USER SPATIAL PROCESSING TECHNIQUES

Multi user spatial Processing, Dynamic resectoring- Range and capacity extension Range and Capacity analysis using smart antennas. Spatio temporal channel models. Spatial Channel Measurements, Application of Spatial Channel Models, Environment and signal parameters.

UNIT IV **9 Hours**

DOA ESTIMATION

DOA estimation, conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using Eigen decomposition. DOA Estimation under Coherent Signal Conditions, The Integrated Approach to DOA Estimation, Direction finding and true ranging PL systems.

UNIT V **9 Hours**

ANTENNA MEASUREMENT

Introduction to Simulation tools for smart antenna design- ADS, HFSS. Introduction to Vector Network Analyzer, Antenna test range Design.

Total: 45 Hours

Reference(s)

1. T.S. Rappaport and J.C. Liberti, Smart Antennas for Wireless Communications, Prentice Hall, 2007.
2. Tapan K Sarkar, Smart Antennas, IEEE Press, John Wiley & Sons Publications,2004.
3. L.C. Godara, Applications of antenna arrays to mobile communications, Part I: Performance improvement, feasibility, and system considerations, Proc. IEEE, vol. 85, no.7, pp.1031-1060, 2003.

22EC037 SOFT COMPUTING TECHNIQUES 3 0 0 3

Course Objectives

- To understand Fuzzy logic and Neural Network concepts
- To acquire the basic knowledge of Genetic algorithms
- To equip the students with the latest application of soft computing

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO8 Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams

PO9 Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and leareive clear instructions.

PO10 Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. .

PO11 Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the various types of Classical sets, Fuzzy sets with its properties
2. Analyze the basics of artificial neural networks
3. Analyze the key concepts of Neuro Fuzzy systems
4. Analyze the various operations involved in the genetic algorithms
5. Analyze the concepts of soft computing for various Applications

Articulation Matrix

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

UNIT I **9 Hours**

FUZZY SYSTEMS

Fuzzy Sets, operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

UNIT II **9 Hours**

NEURAL NETWORKS

Basic concepts-knowledge based processing-single layer perceptron-multilayer perceptron-supervised band unsupervised learning-feed forward and back propagation and counter propagation networks-kohens self organizing networks.

UNIT III **9 Hours**

NEURO-FUZZY MODELING

Adaptive neuro fuzzy inference systems-classification and regression trees- data clustering-rule base structure identification.

UNIT IV **9 Hours**

GENETIC ALGORITHMS

Basic Concepts-Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators - CrossOver -Inversion and Deletion -Mutation Operator -Bit-wise Operators-Convergence of Genetic Algorithms.

UNIT V **9 Hours**

APPLICATIONS OF SOFT COMPUTING

Fuzzy techniques for inverted pendulum case-SIRM fuzzy systems-MCDM for weather forecasting and financial marketing-Neural networks for pattern recognition-TS problems-Routers. GA application to metabolic modelling.

Total: 45 Hours

Reference(s)

1. Samarjeet Borah, Ranjit Panigrahi, Applied Soft computing: Techniques and Applications,2022.
2. Timothy J. Ross, McGraw Hill Inc, Fuzzy Logic with Engineering Applications,2000.
3. Madan M Gupta, Naresh K Sinha, Soft Computing and Intelligent Systems: Theory and Applications, Academic Press,1999.
4. Rajasekaran, G A Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India, 2003.
5. S N Sivanandam, S Sumathi, S N Deepa,5. Neural Networks using MATLAB, Tata McGraw Hill, 2005.
6. David E Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson Education, 1996.

22EC038 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- To familiarize with the basic concepts and models of the operations research.
- To use transportation and assignment model techniques for effective decisions making.
- To optimization that are tailored to large-scale statistics and machine learning problems.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the basics of convex optimization in linear programming
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Analyze the modern optimization techniques in Genetic Algorithm.
4. Analyze the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Analyze the various optimization techniques involved in PSO.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF CONVEX OPTIMIZATION

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

UNIT II **9 Hours**

STOCHASTIC AND NONCONVEX OPTIMIZATION

Dual averaging, Polyak Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning.

UNIT III **9 Hours**

MODERN OPTIMIZATION IN GA

Genetic algorithm: Introduction, biological background, traditional optimization and search techniques, Genetic basic concepts, operators, Encoding scheme, Fitness evaluation, crossover, mutation, genetic programming, multilevel optimization, real life problem, advances in GA.

UNIT IV **9 Hours**

GENETIC PROGRAMMING

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems.

UNIT V **9 Hours**

PARTICLE SWARM OPTIMIZATION

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO)- Formulations, Pseudo-code. Applications of PSO and ACO.

Total: 45 Hours

Reference(s)

1. Stephen Boyd, Convex Optimization, Lieven Vandenberghe book.
2. Introductory Lectures on Convex Optimization, Nesterov old book.
3. Kalyanmoy Deb, Optimization for Engineering Design, PHI Publishers
4. D.E. Goldberg, Addison, Genetic algorithms in Search, Optimization, and Machine learning, Wesley Publishers.

22EC039 MACHINE LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To apply Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environments that are suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO11 Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the basics concepts of machine learning.
2. Implement probabilistic discriminative and generative algorithms for regression and classification problems and analyze the results.
3. Design an unsupervised algorithm to predict the continuous and categorical data and analyze the results.
4. Implement machine learning algorithms and solve real-world problems.
5. Analyze machine learning models for regression and classification problems.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, -hypothesis space and inductive bias, evaluation, cross-validation.

UNIT II **10 Hours**

SUPERVISED LEARNING

Regression-Linear and multilinear regression, polynomial, decision trees, random forest, support vector machine(svm). Classification- k-nearest neighbour algorithm, Classification and Regression Tree, logistic regression, SVM

UNIT III **10 Hours**

UNSUPERVISED LEARNING

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

UNIT IV **9 Hours**

NEURAL NETWORKS

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

UNIT V **9 Hours**

APPLICATION

Machine Learning Frameworks- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

Total: 45 Hours

Reference(s)

1. John Paul Mueller, Luca Massaron, Machine Learning for Dummies, second edition, Wiley, 2021
2. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence a Modern Approach, Prentice Hall, Fourth edition, 2020
3. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020
4. T.M. Mitchell, Machine Learning, McGraw-Hill 2017
5. Stephen Marsland, Machine Learning an Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

22EC040PYTHON PROGRAMMING FOR AI AND ML

3 0 0 3

Course Objectives

- To understand the basics of algorithmic problem-solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, and dictionaries to represent complex data.
- To utilize the Python libraries for interpreting data and visualization of data.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Use an algorithmic solution to design a simple computational problem.
2. Develop and execute simple Python programs.
3. Execute simple Python programs using conditional and loop statements.
4. Analyze compound data using Python lists, tuples, dictionaries etc.
5. Use the Python Libraries to interpret and explore data.

Articulation Matrix

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

UNIT I **9 Hours**

COMPUTATIONAL THINKING AND PROBLEM SOLVING

Fundamentals of Computing - Identification of Computational Problems - Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II **9 Hours**

DATA TYPES, EXPRESSIONS, STATEMENTS

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

UNIT III **9 Hours**

CONTROL FLOW, FUNCTIONS, STRINGS

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV **9 Hours**

LISTS, TUPLES, DICTIONARIES

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as a return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V **9 Hours**

PYTHON LIBRARIES AND DATA VISUALIZATION

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 - pivot tables-Importing Matplotlib - Line plots - Scatter plots - visualizing errors - density and contour plots - Histograms - legends - colors - subplots - Visualization with Seaborn.

Total: 45 Hours

Reference(s)

1. Python for Programmers, by Paul Deitel and Harvey Deitel Pearson Education, 1st Edition, 2021
2. Computational Thinking: A Primer for Programmers and Data Scientists by G Venkatesh and Madhavan Mukund, 1st Edition, Notion Press, 2021
3. Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data by John V Guttag, Third Edition, MIT Press, 2021
4. Computational Thinking: A Beginner""s Guide to Problem Solving and Programming, by Karl Beecher, 1st Edition, BCS Learning & Development Limited, 2017.
5. Think Python: How to Think like a Computer Scientist by Allen B. Downey, 2nd Edition, O Reilly Publishers, 2016.

22EC041 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real world applications
- To analyze the performance of deep learning architectures for real time applications

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning.
3. Apply deep learning concepts in the text and image processing.
4. Implement deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION TO MACHINE LEARNING

Overview of machine learning, linear classifiers, loss functions, Stochastic gradient descent, back-propagation

UNIT II **9 Hours**

INTRODUCTION TO DEEP NEURAL NETWORKS

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization

UNIT III **11 Hours**

DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering

UNIT IV **11 Hours**

DEEP GENERATIVE MODELS

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

UNIT V **7 Hours**

DEEP REINFORCEMENT LEARNING

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

Total: 45 Hours

Reference(s)

1. Magnus Ekman, Addison-Wesley, Learning Deep Learning, 2021
2. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

22EC042 NATURAL LANGUAGE PROCESSING 3 0 0 3

Course Objectives

- To understand the theory and methodology of natural language understanding and generation.
- To analyze topics include stemming, lemmatization, parts of speech tagging, parsing, and machine translation.
- To design employing specialized libraries, students develop applications for topic modelling, sentiment analysis, and text summarization.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO11 Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze Extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing.
2. Analyze the syntax, semantics, and pragmatics of a statement written in a natural language.
3. Develop a conversational agent that uses natural language understanding and generation.
4. Apply machine learning algorithms to natural language processing.
5. Develop scripts and applications in Python to carry out natural language processing using libraries such as NLTK, Gensim, and spaCY.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NLP PHASES AND PYTHON

Introduction, Natural Language Processing, History, Advantages and Disadvantages of NLP, Components and Applications of NLP, Difference between NLP and Computer Language, NLTK-Natural language Toolkit, Python3, and Jupyter Notebook, Introduction to HPC High Performance Computing,

UNIT II **9 Hours**

NLP IN ARTIFICIAL INTELLIGENCE

To build an NLP Pipeline, Phases of NLP, Lexical Analysis, Syntactic Analysis, Semantic Analysis, Discourse Integration, Pragmatic Analysis, Textual Sources, and formatting, Web Scraping, Building the Corpus, Tokenization the corpus, N-Grams, Stemming and Lemmatization, Synsets and Hypernyms.

UNIT III **9 Hours**

NLP APIS AND LIBRARIES

IBM Watson API, Chatbot API, Speech to text API, Sentiment Analysis API, Translation API, Text Analysis API, Cloud NLP API, Google Cloud Natural API, Scikit Learn, NLTK Natural Language toolkit, Pattern, Text blob, Quepy, SpaCY, Gensim.

UNIT IV **9 Hours**

NLP IN MACHINE LEARNING

Machine Learning for Natural Language Processing, Supervised Machine Learning for Natural Language Processing and Text Analytics, Unsupervised Machine Learning for Natural Language Processing and Text Analytics, ML vs NLP and Using Machine Learning on Natural Language Sentences, Hybrid Machine Learning Systems for NLP.

UNIT V **9 Hours**

NLP IN DEEP LEARNING

Dependency Parsing, Neural Machine Translation and attention, Neural Networks, RNNs and Language models, Transformers and Pretaining, Using PyTorch from scratch, Word vectors.

Total: 45 Hours

Reference(s)

1. Natural Language Processing: A Machine Learning Perspective by Yue Zhang, Zhiyang Teng, 2021.
2. Natural Language Processing Succinctly by Joseph D Booth, 2018.
3. Deep Learning for NLP and Speech Recognition by Uday Kamath, John Liu, James Whitaker, First Edition, 2019.
4. Natural Language Processing with Python by Steven Bird, Ewan Klein, Edward Loper, 2009.
5. Neural Network Methods for Natural Language Processing by Yoav Goldberg, 2017.

22EC043 MEDICAL ELECTRONICS AND INSTRUMENTATION

3 0 0 3

Course Objectives

- To study the generation of bio-potentials, its representation recording
- To understand electrical and non-electrical parameter measurements
- To study the various diagnostic and therapeutic equipment

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the concepts of Electro-Physiology and Bio-Potential Recording.
2. Analyze Bio medical and non-electrical parameter measurements.
3. Analyze the concepts of Assist Devices and Bio-Telemetry
4. Analyze the various operations involved in Radiological Equipment
5. Analyze recent trends in Medical Instrumentation

Articulation Matrix

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

UNIT I **9 Hours**

ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING

The Origin of Bio-potentials; bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, EOG, lead systems and recording methods-typical waveform and signal characteristics.

UNIT II **9 Hours**

BIO- CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT

PH, PO2, PCO2, PHCO3, Electrophoresis, colorimeter, photometer, Autoanalyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters

UNIT III **9 Hours**

ASSIST DEVICES AND BIO-TELEMETRY

Cardiac pacemakers, DC Defibrillator, Telemetry principles, frequency selection, Bio-telemetry, radio-pill and tele-stimulation, Signal sources for Analog I/O, Digital I/O waveform generation for testing and calibration

UNIT IV **9 Hours**

RADIOLOGICAL EQUIPMENTS

Ionizing radiation, Diagnostic x-ray equipment, use of Radio Isotope in diagnosis, Multi section Radiography, plane of movement-Radiation Therapy

UNIT V **9 Hours**

RECENT TRENDS IN MEDICAL INSTRUMENTATION

Thermograph, endoscopy unit, Lasers in medicine, Diathermy units, Electrical safety in medical equipment Patient monitoring system.

Total: 45 Hours

Reference(s)

1. Leislie Cromwell, Bio medical Instrumentation and Measurement, PHI,2007
2. David Prutchi and Michael Norris, Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design construction and test of Medical Device,2004.
3. RS Khandpur, Hand book of Bio medical Instrumentation, Tata McGraw-Hill,2005.
4. Joseph J. Carr and John M. Brown, Introduction to Bio medical equipment Technology, John Wiley, 2004.
5. David Prutchi and Michael Norris, Design and Development of Medical Electronic Instrumentation :A Practical perspective of the design construction and test of Medical Device, 2004.

22EC044 CONSUMER ELECTRONICS 3 0 0 3

Course Objectives

- Understand the basics of audio and video technology.
- Understand the electronic gadgets and telecommunication systems.
- Explain the working concepts of consumer appliances.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the various Microphones and Loudspeakers used in real time applications.
2. Analyse different techniques involved in audio processing.
3. Analyse the various video standards and systems.
4. Analyze the various technologies involved in communication and consumer gadgets.
5. Analyze the evolution and development of Modern Consumer applications.

Articulation Matrix

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

UNIT I **9 Hours**

AUDIO SYSTEM COMPONENTS

Introduction to wave motion -Interference and superposition of waves- Beats, Resonance, Echos- characteristics of microphones- types of microphones- wireless microphones-types of headphones- Types of loudspeakers- Multispeaker Systems-Acoustic Insulation and acoustic design. Stereo systems and multiway systems

UNIT II **9 Hours**

AUDIO PROCESSING

Audio Filters, Types of AGC -Loudspeaker Impedance matching- Pre-emphasis and De-emphasis noise reduction- Optical recording and reproduction- stereophony, Quadraphony-Stereo controls- Active tone control, filtering, bass and treble control-Integrated Stereo amplifier- Equalizers- Codecs -LPC, Sub-band Coding, CELP. MPEG-1, MPEG-2, MPEG-4 and Dolby Digital.

UNIT III **9 Hours**

VIDEO STANDARDS AND SYSTEMS

Elements of a TV system, scanning process- resolution, interlacing, composite signal- Types of TV camera-compatibility between monochrome and colour TV - TV standards- NTSC, PAL, SECAM, CCIR-B.

UNIT IV **9 Hours**

COMMUNICATION AND CONSUMER GADGETS

Radio system- VHF and UHF- Types of mobile phones-Facsimile machine- electronic calculators- digital clocks- Automobile computers- Antilocking Breaking Systems, Electronically Controlled Suspension, Safety Belt System, Navigation System- Microwave Ovens. Dish washers and TV Remote.

UNIT V **9 Hours**

CONSUMER APPLICATIONS

Washing Machines- electronic controller, fuzzy logic, Hardware and Software development- Air Conditioners- Components, Remote Controls, Bar Coders- Bar codes, scanner and decoder- Set Top Box- Types, firmware development, Interactive program guides. Video on demand.

Total: 45 Hours

Reference(s)

1. S.P. Bali, Consumer Electronics, Pearson Education, 2005.
2. C.A. Schuler and W.L. Mc Namee, Modern Industrial Electronics, McGraw Hill, 2002.
3. D.J. Shanefield, Industrial Electronics for Engineers, Chemists and Technicians, Jaico Publishing House, 2007.

22EC045 NANO ELECTRONICS 3 0 0 3

Course Objectives

- To study the channel and gate effect of MOS system
- To understand nanotube FETs and MOSFETs
- To study the recent trends of nano devices in the industry

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the basic concepts of nanotechnology
2. Analyze the concepts of nanoelectronics
3. Demonstrate the concept of Silicon MOSFET and quantum transport devices
4. Analyse the process involved in carbon nanotubes
5. Analyze the concept of molecular electronics.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NANOTECHNOLOGY

Background to nanotechnology: Types of nanotechnology and nano machines; MolecularNanotechnology: Electron microscope-scanning electron microscope-atomic force microscope-scanning tunnelling microscope-nano manipulator-nano tweezers-atom manipulation-nanodots; Top down and bottom-up approaches: self assembly-dip pen nano lithography. Nanomaterials: preparation-plasma arcing-chemical vapor deposition-sol-gels-electrodeposition ballmilling

UNIT II **9 Hours**

FUNDAMENTALS OF NANOELECTRONICS

Fundamentals of logic devices: -Requirements-dynamic properties-threshold gates; physicallimits to computations; concepts of logic devices: -classifications-two terminal devices-fieldeffect devices-coulomb blockade devices-spintronics-quantum dot cellular automata-quantum computing-DNA computer, Ultimate computation: -power dissipation limit-dissipation in reversible computation.

UNIT III **9 Hours**

SILICON MOSFETS

Silicon MOSFETS-Novel materials and alternate concepts:-fundamentals of MOSFETDevices-scaling rules-silicon-dioxide based gate dielectrics-metal gates-junctions & contacts-advanced MOSFET concepts. Quantum transport devices based on resonant tunneling: -Electrontunneling-resonant tunneling diodesresonant tunneling devices; Single electron devices forlogic applications: -Single electron devices

UNIT IV **9 Hours**

CARBON NANOTUBES

Carbon Nanotube: Fullerenes-types of nanotubes-formation of nanotubes-assemblies-purification of carbon nanotubes-electronic propertics-synthesis of carbon nanotubes-carbonnanotube interconnects carbon nanotube FETs-Nanotube for memory applications.

UNIT V **9 Hours**

MOLECULAR ELECTRONICS

Electrodes & contacts-functions-molecular electronic devices-first test systems-simulation and circuit design-fabrication; Future applications.

Total: 45 Hours

Reference(s)

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and BurkhardRaguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall /CRC, 2002
2. T. Pradeep, NANO: The Essentials-Understanding Nanoscience and Nanotechnology, TMH, 2007
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2012
4. Saito, S., Carbon Nanotubes for Next-Generation Electronics Device, Science 278(5335): 77-78. doi:10.1126/science.278.5335.77
5. George W. Hanson, Fundamentals of nano electronics, Prentice Hall, 2008

22EC046 AUTOMOTIVE ELECTRONICS AND NETWORKING

3 0 0 3

Course Objectives

- To gain the basic knowledge about automotive systems.
- To study the characteristics of automotive sensors and actuators.
- To understand the fundamentals of automotive networking in new generation vehicles.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Apply the fundamentals and concept of electronics in automotive industry.
2. Analyze the functionalities of automotive sensors.
3. Analyze the concepts of automotive actuators in modern vehicles.
4. Apply the basic knowledge of electronics in vehicular architecture.
5. Asses the most suitable networking topologies for a new generation automotive system.

Articulation Matrix

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

UNIT I **8 Hours**

FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS

Automobile systems: Engine and its control - Ignition systems - Steering systems - Control systems: proportion controller, Proportional Integral controller and Proportional Integral differential controller.

UNIT II **10 Hours**

AUTOMOTIVE SENSORS

Sensor basics &its Functions - Air mass flow sensor- Crankshaft angular position sensor - Throttle valve sensor – Eddy current sensors -Hall sensors -Exhaust gas oxygen sensors- Ultrasound sensor - GPS and distance travelled measurement.

UNIT III **9 Hours**

AUTOMOTIVE ACTUATORS

Fuel Injectors - Exhaust gas recirculation Actuator - Electronic Ignition sub-systems - Digital Engine control systems: Speed density method - Idle speed control method- EGR control - Distributor-less Ignition control.

UNIT IV **9 Hours**

VEHICULAR ELECTRONICS ARCHITECTURE

Intelligent Power distribution module - Supplemental restraint systems - Body control module - Engine control modules - Automatic drive positioned control unit - Driver seat control module - Front air control unit and transmission control unit.

UNIT V **9 Hours**

AUTOMOTIVE NETWORKING

Networking basics topologies - Addressing - Control mechanisms: Event control & Timer control - Network topologies for new generation vehicles - Bus systems: CAN Bus, High speed CAN, LIN bus, MOST bus, Bluetooth: Piconet and scatternet.

Total: 45 Hours

Reference(s)

1. Konrad Reif -Automotive Mechatronics Automotive Networking, Driving Stability Systems, Electronics-Vieweg-Teubner Verlag 2015.
2. Najamuz Zaman, Automotive Electronics Design Fundamentals-Springer International Publishing 2015.
3. Robert Bosch GmbH, Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive-Springer Vieweg 2014.
4. William Ribbens-Understanding Automotive Electronics, Fifth Edition-Newnes 1998.
5. W.H. Crouse, Automobile Electrical Equipment, McGraw-Hill, 1996.
6. P.L. Kholi, Automotive Electrical Equipment, Tata McGraw-Hill, 1995.

22EC047 PCB DESIGN AND FABRICATION 3 0 0 3

Course Objectives

- Understand the basic concepts involved in PCB design
- Design a circuit schematic and PCB layout
- Prototype the PCB and analyze the manufacturing and assembly techniques

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the basic concepts involved in the PCB design
2. Design a circuit schematic using electronic components
3. Design a PCB layout and realize the manufacturing data
4. Design a PCB for High Speed Circuits
5. Develop a prototype model and understand the PCB manufacturing process and PCB assembly process

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF PCB

PCB - Overview, History, Challenges, Market - Classification of PCB - Classes of PCB Design - PCB Laminates - Terminologies in PCB - VIAS - PCB Design Process CAD /CAM Operation - Industry Standard PCB Design Tools

UNIT II **9 Hours**

SCHEMATIC DESIGN AND FOOTPRINT CREATION

Reading Drawings and Diagrams - Schematic symbols for common electronic components - Symbol Properties - Reference Designators - BoM - ERC - Symbol Creation - Mounting Technologies - Through Hole and SMD - Component Library Creation - PTH Components Footprint Designing - SMD Components Footprint Designing as per IPC 7351Standards

UNIT III **9 Hours**

LAYOUT PLANNING AND DESIGN

General PCB Consideration - Mechanical and Electrical Design Consideration - PCB Stack up - Component Placement Rules - Conductor Orientation, Routing and spacing - Current and Impedance Calculation - Holes and Solder PAD - Automatic routers for PCB design - Layout Verification - DRC, Net, LVS - Layout Design Check list - DRC - Gerber File - PCB Design Check List

UNIT IV **9 Hours**

HIGH SPEED PCB DESIGN

High-Speed Design Considerations - Signal Integrity - Need for Signal Integrity - Causes of Signal Integrity Issues in a PCB - Electromagnetic Compatibility (EMC) - EMI - Sources of EMI - Best PCB Design Practices for EMC - Power Integrity - Component Placement Considerations in High-Speed PCBs -Separating Analog and Digital Circuits - Component Orientation - High-Speed Routing Strategy - Differential Pair Signals - Length Matching - High-Speed PCB Design Checklist

UNIT V **9 Hours**

PCB FABRICATION

PCB Safety Guidelines - CAM Editing - Single Layer, Double Layer and Multilayer PCB Board Manufacturing Process - PCB Defects - PCB Assembly Process - Through Hole and SMD - Quality Assurance - Acceptance Criteria

Total: 45 Hours

Reference(s)

1. R.S. Khadhapur, Printed Circuit Boards: Design, Fabrication and Assembly, McGraw Hill Companies, Electronic Engineering, 2006.
2. Earl Gates, Introduction to Basic Electricity and Electronics Technology, Delmar Cengage Learning, 2013.
3. Kraig Mitzner, Complete PCB Design using OrCAD Capture and Layout, Newnes, 2007.
4. Clyde F. Coombs, Printed Circuits Handbook, McGraw Hill, Sixth Edition, 2008.
5. Sd. Mehta, Electronic Product Design Vol. 1 Basics of PCB Design, S Chand & Company Pvt. Ltd, 2011.
6. Bosshart Walter C, Printed Circuit Boards, Tata Mcgraw Hill Publishing Company Limited, 1984.

22EC048 CRYPTOGRAPHY AND NETWORK SECURITY

3 0 0 3

Course Objectives

- Understand the basic concept of Cryptography and Network Security, their mathematical models.
- To understand the necessity of network security, threats/vulnerabilities to networks and counter measures.
- To understand Authentication functions with Message Authentication Codes and Hash Functions.
- To provide familiarity in Intrusion detection and Firewall Design Principles.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the network security fundamental concepts and principles.
2. Apply various models for Encrypt and decrypt messages using block ciphers and network security technology and Protocols.
3. Analyze key agreement algorithms to identify their weaknesses.
4. Analyze the different types of Message Authentication and Hash functions.
5. Assess different types of threats, malware, spyware, viruses, vulnerabilities.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO CONVENTIONAL ENCRYPTION MODELS

Security Services, Mechanisms, and Attacks, A Model for Internetwork security, Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques. Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Block Cipher Design Principles.

UNIT II **9 Hours**

ENCRYPTION TECHNIQUES

Triple DES, International Data Encryption algorithm, Blowfish, RC5, Characteristics of Advanced Symmetric Block Ciphers. Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

UNIT III **9 Hours**

PUBLIC KEY CRYPTOGRAPHY

Principles, RSA Algorithm, Key Management, Diffie Hellman Key exchange, Elliptic Curve Cryptography.

Number Theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat and Euler"s theorems, Testing for primality, Euclid Algorithm, the Chinese remainder theorem, Discrete logarithms.

UNIT IV **9 Hours**

MESSAGE AUTHENTICATION AND HASH FUNCTIONS

Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions, and MACs. Hash and Mac Algorithms: MD-5, Message Digest Algorithm, Secure Hash Algorithm. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications: Kerberos, Electronic Mail Security: Pretty Good Privacy, SIME/MIME.

UNIT V **9 Hours**

IP AND WEB SECURITY

IP security: Overview, Architecture, Authentication, Encapsulating Security Payload, Key Management. Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. Intruders, Viruses, and Worms: Intruders, Viruses and Related threats. Fire Walls: Fire wall Design Principles, Trusted systems.

Total: 45 Hours

Reference(s)

1. Atul Kahate, Cryptography and Network Security, Mc Graw Hill, 4th Edition, 2017.
2. William Stallings, Cryptography and Network Security - Principles and Practice, Pearson Education, 6th Edition, 2013.
3. BehrouzA.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.

22EC049 SCRIPTING LANGUAGES FOR VLSI DESIGN AUTOMATION

3 0 0 3

Course Objectives

- Analyze requirements of software systems to determine the suitability of implementing in scripting languages.
- Apply effective knowledge of Perl and Python to new situations and learn from the experience.
- Analyze problems and synthesize suitable solutions.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO4 Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions..

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Apply basic commands of Linux to work in Linux environment.
2. Apply basic commands of PERL in designing basic systems.
3. Apply PERL in writing scripts for building CMOS designs.
4. Design and run scripts using TCL in IC design flow.
5. Apply basics of JAVA and PYTHON scripting for designs.

Articulation Matrix

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

UNIT I **9 Hours**

LINUX BASICS

Introduction to Linux, File System of the Linux, General usage of Linux kernel 7 basic commands, Linux users and group, Permissions for file, directory and users, Searching a file & directory, Zipping and unzipping concepts.

UNIT II **9 Hours**

INTRODUCTION TO SCRIPTS AND PERL LANGUAGE

Characteristics and uses of scripting languages, Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, File handles, Operators, Control structures, Regular expressions, Built in data types, Statements and declarations- simple, Compound, Loop statements, Global and scoped declarations.

UNIT III **9 Hours**

PERL SCRIPTING

PERL built-in functions, Collections of Data, Working with arrays, Lists and hashes, Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments.

UNIT IV **9 Hours**

TCL FUNDAMENTALS

TCL Fundamentals, String and Pattern Matching, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures and Scope, Working with Strings, Patterns, Files and Pipes, Example code.

UNIT V **9 Hours**

OTHER LANGUAGES

JavaScript - Object models, Design Philosophy, Versions of JavaScript, The Java Script core language, Introduction to Python, Using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

Total: 45 Hours

Reference(s)

1. David Barron, "The World of Scripting Languages", Wiley Student Edition, 2010.
2. Randal L, Schwartz Tom Phoenix, "Learning PERL", Oreilly Publications, 3rd Edn., 2000.
3. Igor Markov and Michael L. Bushnell "Scripting in VLSI CAD" Springer Publications, 2000.
4. Kurt Keutzer, Sharad Malik, and Rob M. A. (Bob) van der Geijn “Scripting for VLSI Design Automation” Kluwer Academic Publishers 1998.

22EC050 5G MOBILE AND WIRELESS COMMUNICATION

3 0 0 3

Course Objectives

- Students will gain a foundational knowledge of 5G channel modelling, network architecture, radio access technologies, and key enabling technologies.
- Students will be able to analyse the strengths and weaknesses of different functional splits in the 5G architecture for specific applications.
- Students will apply their understanding to propose solutions or design considerations for integrating D2D communication into existing network architectures.

Program Outcomes (POs)

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

PO2 Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3 Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment

PO5 Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems..

PO6 Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the spectrum requirements for 5G, different channel modeling scenarios, and propagation characteristics.
2. Design a basic 5G network architecture considering functional splits and specific application requirements.
3. Analyze the impact of diversity techniques on channel variability and performance in D2D scenarios.
4. Assess the performance of different access technologies for massive machine-type communication in terms of capacity and efficiency.
5. Design interference management techniques for specific network scenarios like ultra-dense networks or moving relay nodes.

Articulation Matrix

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

UNIT I **9 Hours**

5G CHANNEL MODELLING AND USE CASES

Spectrum for 5G, Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying.

UNIT II **9 Hours**

THE 5G ARCHITECTURE

Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR), NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications.

UNIT III **9 Hours**

DEVICE-TO-DEVICE (D2D) COMMUNICATIONS

Diversity gain, receive antenna diversity, transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, combined space and path diversity, Indirect transmit diversity, Diversity of a space, time, frequency selective fading channel.

UNIT IV **9 Hours**

The 5G RADIO-ACCESS TECHNOLOGIES

Access design principles for multi-user communications, Orthogonal multiple-access systems, spread spectrum multiple access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.

UNIT V **9 Hours**

INTERFERENCE MANAGEMENT, MOBILITY MANAGEMENT, AND SECURITY FOR 5G

Network deployment types, Ultra-dense network or densification, Heterogeneous networks, Interference management in 5G, Interference management in UDN, Mobility management in 5G, User equipment controlled versus network-controlled handover, Mobility management in heterogeneous 5G networks.

Total: 45 Hours

Reference(s)

1. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2011
2. Erik Dahlman, Stefan Parkvall, Johan Sköld 5G NR: The Next Generation Wireless Access Technology, Elsevier, First Edition, 2016
3. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley, 2010
4. https://nptel.ac.in/courses/108/105/108105134/
5. https://www.udemy.com/course/5g-mobile-networks-modern-wireless-communication-technology/

22EC051 EMBEDDED PRODUCT DESIGN AND DEVELOPMENT

3 0 0 3

Course Objectives

- To understand the generic product development process, phases, and organizational structures to manage product innovation effectively.
- To apply Systematic Approaches in Product Development by Exploring architecture creation, prototyping principles, economic analysis, and benchmarking strategies for effective product design.
- To Implement industrial design strategies by integrating CAE, CAD, and CAM tools, applying reverse engineering techniques, and analysing real-time embedded software reuse for optimized product performance.
- To comprehend Electronic Product Development Stages by embedding product modelling, PCB design, software testing methodologies, and thermal/noise management through case studies.
- To create general embedded system architectures, select appropriate hardware/software components, and apply debugging, testing, and documentation techniques.
- To enhance practical knowledge through case studies and real-world applications like smart energy meters, intelligent traffic controllers, and water quality monitoring systems for embedded product development.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Describe the basics concept of product design, product features and its architecture.
2. Understand the stages in product design and development for industrial applications.
3. Familiarize the concepts of industrial design strategies with appropriate case studies.
4. Apply suitable methods by considering various factors involved in modeling a product
5. Design a simple product using suitable firmware development tools.

Articulation Matrix

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

UNIT I **9 Hours**

CONCEPTS OF PRODUCT DEVELOPMENT

Need for PD- Generic Product Development Process Phases- Product Development Process Flows- Product Development organization structures- Understanding customer and behaviour analysis. Concept Generation, Five Step Method-Basics of Concept Selection-Creative thinking –creativity and problem-solving- creative thinking methods- generating design concepts.

UNIT II **9 Hours**

APPROACHES IN PRODUCT DEVELOPMENT

Product development management - establishing the architecture - creation - architecture of the chunks - creating detailed interface specifications - Portfolio Architecture-competitive benchmarking- Approach for the benchmarking Process-Principles of prototyping – Planning for prototypes- Economic & Cost Analysis -Testing Methodologies- Product Branding.

UNIT III **9 Hours**

INDUSTRIAL DESIGN STRATEGIES

Role of Integrating CAE, CAD, and CAM tools for Simulating product performance and manufacturing processes electronically- Basics on reverse engineering – Reverse engineering strategies – Finding reusable software components – Recycling real-time embedded software-based approach and its logical basics–Case study on Visualization of smart city: PHEV.

UNIT IV **9 Hours**

ELECTRONIC PRODUCT DEVELOPMENT STAGES

Product Development Stages -Embedded product modelling - Grounding and noise elimination methods, Thermal protection with heat management – PCB design steps – Software design and testing method – documentation, Case study on smart energy meter.

UNIT V **9 Hours**

EMBEDDED PRODUCTS DESIGN

Creating general Embedded System Architecture (with Case study example: Water quality monitoring system) -Intelligent traffic controller, smart streetlight- Architectural Structures - Criteria in selection of Hardware & Software Components-Choosing Bus Communication Standards, need for Developing with IDE, Translation & Debugging Tools & Application Software, Performance Testing, Costing, Benchmarking, Documentation.

Total: 45 Hours

Reference(s)

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development",McGraw –Hill International Edns.1999/ Tata McGrawEducation, ISBN-10-007-14679-9.
2. R.G. Kaduskar and V.B. Baru, “Electronic Product Design”, Wiley, 2014.
3. Stephen Armstrong, Engineering and Product Development Management; The Holistic Approach, CAMBRIDGE UNIVERSITY PRESS (CUP),2014
4. Rajkamal, ‘Embedded System-Architecture, Programming, Design’, TMH,2011.
5. KEVIN OTTO & KRISTIN WOOD, “Product Design and Development “, 4th Edition, 2009, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE),2001./ISBN 9788177588217.
6. Yousef Haik, T. M. M. Shahin, “Engineering Design Process”, 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

22EC052 EDGE COMPUTING FOR IOT 3 0 0 3

Course Objectives

- To understand the fundamental concepts, evolution, and architectural models of Edge Computing and its significance in IoT applications.
- To explore the comparative analysis of Edge, Fog, and Cloud Computing and their role in real-time IoT systems.
- To learn advanced data management techniques, real-time analytics, and security protocols for edge-based IoT devices and networks.
- To deploy and optimize AI and ML models on edge devices, including federated learning and TinyML, for efficient and intelligent IoT applications.
- To comprehend the integration of Edge Computing with Industrial IoT (IIoT), digital twins, and cyber-physical systems for Industry 4.0 solutions.
- To gain hands-on experience with real-world edge platforms (AWS Greengrass, Azure IoT Edge) and understand future trends like Edge Intelligence and Swarm Computing.
- To analyze real-life case studies in smart cities, healthcare, autonomous vehicles, and precision agriculture using advanced Edge Computing techniques.

Program Outcomes (POs)

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

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required.

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the fundamental concepts, evolution, and architectural models of Edge Computing and its role in IoT applications.
2. Apply real-time data management techniques, storage models, and advanced security protocols to ensure secure and efficient edge-based IoT systems.
3. Deploy and optimize AI and ML models on edge devices, utilizing techniques like federated learning, model compression, and TinyML for intelligent IoT applications.
4. Evaluate the application of Edge Computing in Industrial IoT (IIoT) systems, including digital twins, cyber-physical systems, and real-time decision-making.
5. Demonstrate the ability to implement and manage real-world edge platforms and analyze future trends like Edge Intelligence, 5G integration, and swarm computing in IoT applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO EDGE COMPUTING AND ARCHITECTURES

Edge Computing: Concept, Evolution, and Need for IoT Applications, Edge vs. Fog vs. Cloud Computing: Comparative Analysis, Edge Computing Architectures: Hierarchical, Distributed, and Hybrid Models, Key Components: Edge Devices, Gateways, and Edge Servers, Advanced Edge Nodes: AI-Powered and Low-Power Edge Devices, Communication Protocols for Edge (LoRaWAN, MQTT, CoAP, OPC-UA).

UNIT II **9 Hours**

EDGE DATA MANAGEMENT AND SECURITY

Real-time Data Processing and Analytics at the Edge, Edge Data Storage Models and Databases, Security Challenges in Edge Computing: Device, Network, and Application-Level Threats, Advanced Encryption and Authentication for Edge IoT Devices, Secure Communication Protocols (TLS/SSL, DTLS), Privacy-Preserving Techniques in Edge Computing.

UNIT III **9 Hours**

ADVANCED EDGE AI AND MACHINE LEARNING MODELS

Deployment of AI and ML Models on Edge Devices, Federated Learning for IoT Edge Applications Model Compression and Optimization Techniques (Quantization, Pruning), Edge-based Computer Vision and Natural Language Processing, TinyML and Lightweight Deep Learning Models for Edge, Case Studies: Predictive Maintenance, Smart Surveillance, and Anomaly Detection.

UNIT IV **9 Hours**

EDGE COMPUTING IN INDUSTRIAL IOT (IIOT)

Edge Computing for Smart Factories and Industry 4.0 Applications, Industrial Protocols and Edge Interoperability (OPC-UA, Modbus), Edge-Based Digital Twins for Predictive Maintenance, Cyber-

Physical Systems with Edge Architecture, Advanced Use Cases: Robotics, Automated Quality Control, and Real-Time Decision Making, Edge-Enabled SCADA Systems.

UNIT V **9 Hours**

REAL-WORLD IMPLEMENTATIONS AND FUTURE TRENDS

Edge Computing Platforms: AWS Greengrass, Azure IoT Edge, Google Edge TPU, Containerization at the Edge: Docker, Kubernetes for Edge Devices, Edge Orchestration and Resource Management 5G Integration with Edge Computing, Future Trends: Edge Intelligence, Autonomous Edge, and Swarm Computing, Case Studies: Smart Cities, Healthcare, Autonomous Vehicles, and Precision Agriculture.

Total: 45 Hours

Reference(s)

1. Mahadev Satyanarayanan, Edge Computing: Principles and Practices, Carnegie Mellon University, 2019.
2. Theo Lynn, John G. Mooney, Brian Lee, and Patricia Takako Endo, The Cloud-to-Thing Continuum: Opportunities and Challenges in Edge Computing, Springer, 2020.
3. Shahed Mazumder, Security and Privacy in Edge Computing, Wiley, 2021.
4. Hsinchun Chen, Shuigeng Zhou, and Keke Chen, Edge Computing: A Security Perspective, Springer, 2020.
5. Pete Warden and Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly Media, 2020.
6. Md. Rezaul Karim, Hands-On Edge AI for IoT: Intelligent Solutions for IoT Developers and Architects, Packt Publishing, 2021.
7. Sabina Jeschke, Christian Brecher, Houbing Song, and Danda B. Rawat, Industrial IoT: From Theory to Applications, Springer, 2017.
8. Rajkumar Buyya and Satish Narayana Srirama, Edge Computing in Industry 4.0: Principles and Applications, Wiley, 2021.
9. Zaigham Mahmood, Edge Computing: Applications, Technologies and Security, Springer, 2019.
10. Rajeev Tiwari and Dhananjay Singh, 5G and Edge Computing for Smart Cities and Industry 4.0, CRC Press, 2022

22EC053 TESTING OF VLSI 3 0 0 3

Course Objectives

- To impart knowledge on fault modeling, fault detection techniques, and their impact on VLSI circuit reliability.
- To equip students with design-for-testability strategies, including scan-based design and built-in self-test methodologies.
- To develop expertise in advanced VLSI testing strategies for ensuring high-performance and reliable circuit designs.

Program Outcomes (POs)

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

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

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

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

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

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application-oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. To understand various fault models, fault detection techniques, and the role of automatic test equipment in VLSI testing.
2. Design and implement scan-based and boundary scan techniques to improve testability and fault diagnosis in digital circuits.
3. Develop and integrate BIST architectures to enhance self-test capabilities and fault tolerance in VLSI systems.
4. Analyze fault models and implement memory testing techniques for improving memory reliability and performance.
5. Formulate and implement advanced testing methodologies to ensure high-quality and reliable VLSI circuit performance.

Articulation Matrix

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

UNIT I **9 Hours**

FAULT MODELS AND FAULT DETECTION

Role of Testing - Automatic Test Equipment - Test Economics - Yield - Faults in Logic Circuits - Breaks and Transistors Stuck-Open and Stuck-On or Stuck-Open - Basic Concepts of Fault Detection - Fault detection in Logic Circuits - ATPG - Path Sensitization.

UNIT II **9 Hours**

DESIGN FOR TESTABILITY (DFT)

Ad Hoc Techniques - Scan-Path Technique for Testable Sequential Circuit Design - Level-Sensitive Scan Design - Random Access Scan Technique - Boundary Scan.

UNIT III **9 Hours**

BUILT-IN SELF-TEST (BIST)

Test Pattern Generation for BIST - Output Response Analysis - BIST Architectures - BILBO - Self-Testing Using an MISR and Parallel Shift Register Sequence Generator - LSSD On-Chip Self-Test.

UNIT IV **9 Hours**

MEMORY TESTING

Memory Density and Defect Trends - Faults - Memory Test Levels - Fault Modeling - Memory Testing.

UNIT V **9 Hours**

ADVANCED TESTING STRATEGIES

Scan-Based Testing - IDDQ Testing - Delay Fault Testing - System-Level Test Strategies - Reliability and Quality Assurance in VLSI Testing.

Total: 45 Hours

Reference(s)

1. M. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits," Springer, 2000.
2. P. K. Lala, "Digital Circuit Testing and Testability," Academic Press, 1997.
3. M. Abramovici, M. A. Breuer, and A. D. Friedman, "Digital Systems Testing and Testable Design," IEEE Press, 1990.
4. N. Jha and S. K. Gupta, "Testing of Digital Systems," Cambridge University Press, 2003

22EC054 QUANTUM COMPUTING 3 0 0 3

Course Objectives

- To introduce the fundamental mathematical concepts and postulates underlying quantum mechanics.
- To understand the representation of quantum states and operations using qubits and quantum gates.
- To analyze and implement basic quantum algorithms for computational problems.
- To study the physical realization of quantum systems and quantum hardware technologies.
- To explore real-world applications of quantum computing in communication, cryptography, and machine learning.

Program Outcomes (POs)

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

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

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

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

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

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application-oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Understand the mathematical foundations and quantum mechanical postulates relevant to quantum computation.
2. Analyze single and multi-qubit systems using quantum gates, circuits, and network components.
3. Apply fundamental quantum algorithms such as Grover’s, Shor’s, and Deutsch–Jozsa algorithms to computational problems.
4. Illustrate the physical realization of qubits and quantum circuits using different technologies like NMR, trapped ions, and superconducting qubits.
5. Evaluate applications of quantum computing in cryptography, communication, error correction, and machine learning.

Articulation Matrix

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

UNIT I **9 Hours**

CONCEPTS OF QUANTUM COMPUTING

Vectors, Complex Numbers, Quantum context of probability, Postulates of quantum mechanics, Computation, State representation, Bra-Ket notation, Hilbert Space (qubits).

UNIT II **9 Hours**

COMPUTING AND NETWORKING COMPONENTS

Tensor products (Unitary & Composite), Qubit Quantum gates (Mono & Double), Quantum diode, router, and memory.

UNIT III **9 Hours**

QUANTUM ALGORITHMS

Quantum key distributions, quantum teleportation, Grover’s algorithm (database search), Shor’s algorithm (integer factorization), Deutsch–Jozsa algorithm, quantum Fourier transform (QFT), overview of open-source software for working with quantum computers at the level of circuits, and algorithms.

UNIT IV **9 Hours**

PHYSICAL REALIZATION OF CIRCUITS

Physical representation of Qubit, Overview on Linear optics quantum computing (LOQC), Quantum electrodynamics (QED), Superconducting quantum computer.

UNIT V **9 Hours**

APPLICATIONS

Communication and Cryptography, Error Correction, Machine Learning, Big Data Search.

Total: 45 Hours

Reference(s)

1. Nielsen, Michael, and Isaac Chuang. Quantum Computation and Quantum Information. Cambridge University Press, 2010.
2. Rieffel, Eleanor, and Wolfgang Polak. Quantum Computing: A Gentle Introduction. MIT Press, 2011.
3. Bernhardt, Chris. Quantum Computing for Everyone. MIT Press, 2019.
4. Preskill, John. Quantum Computing: An Applied Approach. Springer, 2018.
5. Hotta, Masahiro, and Keiji Matsumoto. Quantum Computing: From Linear Algebra to Physical Realizations. Springer, 2020.

22OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Programme Outcomes (POs)

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

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

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

PO11 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO ENERGY SCIENCE

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources

UNIT II **9 Hours**

ENERGY CONSERVATION IN BUILDINGS

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building-classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing

UNIT III **9 Hours**

SUSTAINABLE CONSTRUCTION

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

UNIT IV **9 Hours**

WATER CONSERVATION & SUSTAINABILITY

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

UNIT V **9 Hours**

ENERGY RECOVERY FROM WASTE

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

Total: 45 Hours

Reference(s)

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011.
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

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. 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	PSO1	PSO2
1	1	2	-	-	3	-	-	-	-	-	-	-	-
2	1	2	3	-	3	-	-	-	-	-	-	-	-
3	1	2	2	-	3	-	-	-	-	-	-	-	-
4	1	2	3	-	3	-	-	-	-	-	-	-	-
5	1	2	3	-	3	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading. (sona).

UNIT II **9 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors (PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**

OPERATOR OVERLOADING AND INHERITANCE

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV

POLYMORPHISM AND FILE STREAMS **9 Hours**

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer-Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **9 Hours**

TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S. Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T. Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing New Delhi, 2006.

22OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

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. 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	PSO1	PSO2
1	2	3	2	-	2	-	-	-	-	-	-	-	-
2	2	3	2	-	2	-	-	-	-	-	-	-	-
3	3	3	3	-	3	-	-	-	-	-	-	-	-
4	2	2	2	-	2	-	-	-	-	-	-	-	-
5	2	2	2	-	2	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages-Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S. Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

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

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	PSO1	PSO2
1	2	-	-	-	-	-	-	-	-	-	-	-	-
2	2	3	2	-	-	-	-	-	-	-	-	-	-
3	2	2	2	-	-	-	-	-	-	-	-	-	-
4	3	2	2	2	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS-Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **9 Hours**
INTRODUCTION TO DATA MINING
Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**
ASSOCIATION RULE MINING
Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**
CLASSIFICATION AND CLUSTERING
Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k- medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **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 Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

22OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

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.

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	PSO1	PSO2
1	2	2	-	-	-	-	-	-	-	-	-	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	-
3	3	3	3	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	-	-	-	-	-	-	-	-	-
5	2	2	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**

TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**
MANAGEMENT
Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS
Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**
APPLICATIONS
Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

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.

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	PSO1	PSO2
1	2	3	-	2	3	-	-	-	-	-	-	-	-
2	2	3	-	2	2	-	-	-	-	-	-	-	-
3	2	3	-	3	3	-	-	-	-	-	-	-	-
4	2	2	2	3	2	-	-	-	-	-	-	-	-
5	2	3	-	2	3	-	-	-	-	-	-	-	-

UNIT I **7 Hours**

TEXT MINING

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**
METHODS
Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**
WEB ANALYTICS
Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**
SOCIAL NETWORK ANALYTICS
Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS
Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OEI01 PROGRAMMABLE LOGIC CONTROLLER 3 0 0 3

Course Objectives

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

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

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

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

Course Outcomes (COs)

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION TO AUTOMATION

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II **9 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

UNIT III **8 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV **10 Hours**

ADVANCED PLC FUNCTIONS

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V **8 Hours**

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

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.

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	PSO1	PSO2
1	3	2	1	-	-	-	-	-	-	-	-	-	-
2	3	2	1	2	-	-	-	-	-	-	-	-	-
3	3	2	1	-	-	-	-	-	-	-	-	-	-
4	3	2	2	2	-	-	-	-	-	-	-	-	-
5	3	2	2	2	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

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

UNIT III **9 Hours**

LASER FUNDAMENTALS

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

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

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

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

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

Total: 45 Hours

Reference(s)

1. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India,2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

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.

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	PSO1	PSO2
1	2	2	2	2	2	-	-	-	-	-	-	-	-
2	2	2	2	2	2	-	-	-	-	-	-	-	-
3	2	2	2	2	2	-	-	-	-	-	-	-	-
4	2	2	2	2	2	-	-	-	-	-	-	-	-
5	2	2	2	2	2	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R. Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T. Pham, S. S. Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015
6. http://www.springer.com/978-1-4939-2112-6
7. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

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.

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

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

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

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process Planning-Definition, Procedure, Process selection, Machine capacity, Process sheet. Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models, ABC analysis, Material Requirement Planning (MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T. Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

22OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

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.

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

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

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.

PO11 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	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 sustainabledevelopment
- To give way to the bolster green technology and incline towards more ecofriendly options.

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.

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

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

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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 feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative andthermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

22OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

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.

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

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

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

UNIT I 9 Hours

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products: -Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan, and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

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	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	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	PSO1	PSO2
1	3	2	-	2	-	2	-	-	-	-	-	-	-
2	1	2	-	2	-	1	-	-	-	-	-	-	-
3	2	2	-	1	-	2	-	-	-	-	-	-	-
4	2	3	-	2	-	2	-	-	-	-	-	-	-
5	2	2	-	2	-	3	-	-	-	-	-	-	-

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L. Kent and A.D. Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman), Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition, CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP

3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

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.

PO11 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	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

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

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	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	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

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.

PO11 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 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	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

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).

9 Hours

UNIT II

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	PSO1	PSO2
1	3	3	2	2	1	-	-	-	-	-	-	-	-
2	3	3	2	2	1	-	-	-	-	-	-	-	-
3	3	3	2	2	1	-	-	-	-	-	-	-	-
4	3	3	2	2	1	-	-	-	-	-	-	-	-
5	3	3	2	2	1	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
INTRODUCTION TO BIOPHOTONICS
Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**
PHOTOBIOLOGY
Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**
BIONANO PHOTONICS
Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**
TISSUE ENGINEERING WITH LIGHT
Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**
BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS
An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supra molecules
- To summarize the soft matter properties of structures and components of life

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. Analyze the structural and mechanical differences between soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Analyze 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	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids. Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

Total: 45 Hours

Reference(s)

1. Richard A L Jones, Soft Condensed Matter, Oxford University Press, UK, 2002.
2. Masao Doi, Soft Matter Physics, Oxford University Press, UK, 2013.
3. Ian W Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007.
4. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and Oleg D Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING

3 0 0 3

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. 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. Analyse the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Analyse the rate of corrosion on metals using electrochemical methods of testing
5. Analyse 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	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 the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structural, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

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

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame-retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

22OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Apply the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Compare the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Analyze fuel cells based on its construction, production of current and applications.
4. Analyze methods of storing hydrogen fuel and its environmental applications.
5. Analyze the future prospects of renewable energy, hydrogen economy, and the efficiency of various generations of solar cells in energy production.

Articulation Matrix

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

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium-ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. S.P. Jiang and Q. Li, Introduction to fuel cells, Springer, 2021.
2. M.M. Eboch, The Future of Energy: From solar cells to flying wind farms, Capstone publishers, 2020.
3. N. Eliaz and E. Gileadi, Physical electrochemistry, fundamentals, techniques and applications, Wiley, 2019.
4. J. Garche and K. Brandt, Electrochemical power sources: Fundamentals systems and applications, Elsevier, 2018.
5. A. Iulianelli and A. Basile, Advances in hydrogen production, storage and distribution, Elsevier, 2016.

22OMA01 GRAPH THEORY AND COMBINATORICS

3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory-based computing and network security studies in Computer Science.

Programme Outcomes (POs)

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

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

Course Outcomes (COs)

1. 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	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	-
2	1	3	-	-	-	-	-	-	-	-	-	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003.
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics and Its Applications, McGraw Hil, 2007.
4. Clark J. & Holton D.A, A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Program Outcomes (POs)

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

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

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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.

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

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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.

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

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

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

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY **3 0 0 3**

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Program Outcomes (POs)

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

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

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

PO11 Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the understanding of religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Build 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. Analyze the organizational structure, entry modes, and operational roles of Indian armed forces, CAPF, and NCC while developing leadership capabilities.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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/

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.

PO11 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	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

3 0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

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	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	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 RAIN WATER 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	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 Y O, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR & TI, Dehradun, 1990

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Program Outcomes (POs)

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

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

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan Acquire a sense of responsibility, smartness in appearance and improve self confidence
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22EC0XA MIMO ANTENNA DESIGN AND ITS ANALYSIS

1 0 0 1

Course Objectives

- Students will be able to Design antenna arrays for MIMO systems considering spatial multiplexing and beamforming principles.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze the fundamental concepts of MIMO technology, its applications, and advantages in wireless communication systems.
2. Assess antenna parameters including gain, impedance, radiation pattern, and polarization, and apply this knowledge to antenna selection and design.

Articulation Matrix

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

ANTENNA FUNDAMENTALS AND MIMO REQUIREMENTS

Antenna fundamentals: Gain, impedance, radiation pattern, and polarization, MIMO system requirements: Diversity gain, spatial multiplexing, and channel capacity - MIMO antenna configurations: SIMO, MISO, 2x2 & 4x4, Spatial multiplexing and beamforming concepts - Creating antenna geometries using HFSS tools, Defining material properties, boundary conditions, and excitations - Performing frequency domain simulations for MIMO antennas, Analyzing S-parameters, mutual coupling, and radiation patterns.

Total: 15 Hours

Reference(s)

1. Li, Y., & Wang, W. (2006). MIMO Antenna Technology for Wireless Communications.
2. Huang, J., Zong, Z., & Gao, Y. (2017). MIMO Antenna Technology for Beyond 4G.
3. ANSYS HFSS User Guide and Tutorials: Provided by ANSYS, these guides offer step-by-step instructions on using HFSS for antenna design and simulation.
4. IEEE Antennas and Wireless Propagation Letters: Shorter research articles and letters on the latest developments in antennas and wireless propagation.

22EC0XB NLP BEYOND BASICS 1 0 0 1

Course Objectives

- To explore NLP's Practical Applications, Algorithmic Fundamentals, and Build with Latest LLMs Models.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Demonstrate the idea about NLP, LLMs models and its recent applications.
2. Assess supervised machine learning models based on the text.
3. Analyze the performance of the latest LLMs model.

Articulation Matrix

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

BASIC TO LATEST LLMS CONCEPTS IN NLP

Bag of words(BOG), Term Frequency - Inverse Document frequency(TF-IDF), Word2Vev, FastText, Doc2Vec, LSTM, Transformers, BERT, GPT

Total: 15 Hours

Reference(s)

1. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, First Edition, O'Reilly Media, 2009

22EC0XC 32 BIT MICROPROCESSORS (MPUS) WITH EDGE AI

1 0 0 1

Course Objectives

- To explore the functions and capabilities of 32-Bit Microprocessor, and gain hands-on experience in developing Edge AI applications using ARM development boards.
- The course focuses on understanding the architecture, protocols, and practical aspects of building efficient and reliable Embedded solutions.

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.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the ARM Processor Basics and architecture flow.
2. Integrate ARM development boards with sensors using GPIO pins.
3. Implement and Program 32-bit microprocessor boards for Edge AI applications.

Articulation Matrix

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

ARM DESIGN PHILOSOPHY & RISC ARCHITECTURE

ARM Design Philosophy & RISC Architecture, Programmer's Model. GPIO Configuration, Interfacing IO devices – LEDs, Switches. Timers Basics, PWM, UART, I2C, SPI, ADC & DAC. Introduction to AI and ML concepts. Types of AI, Applications of AI, Advantages and disadvantages of AI. Introduction to ML, Types of Ml algorithms: Supervised learning - Unsupervised learning - Reinforcement learning. Hardware and Software Platforms for AI. Real World Use Cases.

Total: 15 Hours

Reference(s)

1. Shibu K V, ―Introduction to Embedded Systems Tata McGraw Hill Education Private Limited, 2nd Edition.
2. Pete Warden, Daniel Situnayak-TinyML: Machine Learning with Tensor Flow Lite on Arduino and Ultra-Low, O’Reilly,2020.
3. Atul Krishna Gupta, Dr. Siva Prasad Nandyala-Deep Learning on Microcontrollers: Learn how to develop embedded AI applications using TinyML. BPB Publications,2023.
4. https://stm32ai.st.com/#stm32-sann-resourcescontainer
5. https://www.ti.com/technologies/edge-ai.html

22EC0XD IoT APPLICATION DESIGN USING LoRa TECHNOLOGY

0 0 0 1

Course Objectives

- To explore the capabilities of LoRa technology, and gain hands-on experience in developing IoT applications using LoRa devices.

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.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Analyze LoRaWAN protocol and its role in enabling long-range communication.
2. Demonstrate hands-on proficiency in configuring and programming LoRa devices for simple IoT applications.

Articulation Matrix

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

IoT ARCHITECTURE AND APPLICATIONS

IoT Architecture - IIoT Applications - Introduction to ESP32 - Introduction to ESP32 library installation - Hands-On: Integration LED with WDM.Node to Node Communication with LoRa - Install LMIC Library for LoRaWAN Communication- Pin Mapping with Hardware using - Configure LoRaWAN Gateway in Network Serve Decoding the Received Data - Downlink Data from Network Page to End Device. Uplink from End Node to Network Server using OTAA Mode Data Visualization in Application Server with Multiple widgets - Hands on demo: Ultrasonic sensor Data visualization in Application Server

Total: 15 Hours

Reference(s)

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.

22EC0XE EXPERIMENTING NETWORK PROTOCOLS USING ANALYZING TOOLS

1 0 0 1

Course Objectives

- To analyze, troubleshoot, and capture the packets in the network interface.
- To filter packets on many criteria and search for packets on many criteria.
- To create various statistics and colorize packet displays based on filters.

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.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the fundamental elements of networking.
2. Analyze the structure of the network and its various challenges while transferring packets.
3. Differentiate hardware, software, and the aspects involved in networking devices.

Articulation Matrix

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

WIRESHARK: PACKET ANALYSIS AND FILTERS
Wireshark Installation – Wireshark Basics – Capture frames/packets/segments – Port SPAN / Mirroring Wireshark Filters – Demo of Wireshark Display filters – Two types of filters – Wireshark capture filters-IP Address / Protocols – T shark and Term shark – Overview of Wireshark Hacking Passwords.
SPANNING TREE THEORY WITH DEMONSTRATIONS SPANNING Tree Overview – Versions of Spanning Tree – Why Spanning Tree – BPDUs and Bridge IDs – Demo: STP Root – Root Ports and Designated – Extended Bridge ID – Port Fast – Path Cost – PVST versus RPVST Port – RPVST and PVST Interoperability – Demo: 802.1w – 802.1s / MSTP- Spanning Tree Comparison Summary.

GRAPHICAL NETWORK SIMULATOR INTRODUCTION to GNS3 – Basic Terminologies – Creating different network topologies – Ethernet switch devices – protocols – Packet capture – Firewall emulation – Virtual LAN Configuration – Routing protocols ATM switch and bridges.

Total: 15 Hours

Reference(s)

1. Laura Chappell, Gerald Combs, "Wireshark 101: Essential Skills for Network Analysis (Wireshark Solution)", Second Edition, 2017.
2. Laura Chappell, Gerald Combs, "Wireshark Network Analysis: The official Wireshark certified network analyst study guide", Second Edition, 2011.
3. Lisa Bock, "Learn Wireshark: A definitive guide to expertly analyzing protocols and troubleshooting networks using Wireshark" Second Edition, Kindle Edition

22EC0XF AUTOMOTIVE COMMUNICATION BOOT CAMP LIN, OBD AND AUTOSAR **1 0 0 1**

Course Objectives

- Gain a foundational understanding of semiconductor materials, principles, and manufacturing processes.
- Gain insights into reliability testing, failure analysis, and yield enhancement techniques.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze basic semiconductor device’s life cycle from design to release.
2. Analyze the environments, tools, and processes in each stage of the semiconductor’s life cycle.
3. Analyze the importance of design, instruments, and technologies involved, and the role of Electronics engineers in the processes.

Articulation Matrix

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

LIN PROTOCOL:
Lin BUS – CAN bus vs LIN bus – LIN Bus usage – LIN Messages – LIN Bit Timing – LIN Error Handling – LIN Connector – LIN Sleep & Wake-up. **DIAGNOSTIC COMMUNICATION:** Physical and Functional Addressing - ISO14229 UDS: UDS vs ISO OSI Layers – Diagnostic Message Structure & Types – UDS Services – Types of Services: Simple, Periodic & Event-based – UDS Sessions OBD II – OBD vs ISO OSI Layers – OBD Connectors – OBD Services - OBD Parameter ID (PIDs)* **AUTOSAR ARCHITECTURE:** Introduction to Autosar Standard & Consortium – Need for Autosar Architecture – Virtual Function Bus - Layered Architecture Model – Microcontroller Abstraction Layer – ECU Abstraction Layer – Service layer – Autosar example – Classic vs Adaptive Autosar - Secure On-board Communication

Total: 15 Hours

Reference(s)

1. Christoph Marscholik and Peter Subkey, "Road Vehicles – Diagnostic Communication Oliver Scheid", "Autosar Compendium – Part 1"
2. Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flex Ray, and Safe-by-wire." SAE International, Wiley, Automated Embedded Systems: Handbook.
3. https://www.autosar.org/fileadmin/standards/classic/2211/AUTOSAR_EXP_Layered SoftwareArchitecture.pdf

22EC0XG SEMICONDUCTOR LIFE CYCLE 1 0 0 1

Course Objectives

- Gain a foundational understanding of semiconductor materials, principles, and manufacturing processes.
- Gain insights into reliability testing, failure analysis, and yield enhancement techniques.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze semiconductor device's life cycle from design to release.
2. Analyze the environments, tools, and processes in each stage of the semiconductor's life cycle.
3. Analyze the importance of design, instruments, and technologies involved, and the role of Electronics engineers in the processes.

Articulation Matrix

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

15 Hours

OVERVIEW OF SEMICONDUCTOR LIFE CYCLE
High level overview of the semiconductor life cycle – pre-silicon processes, silicon fabrication, post-silicon lab processes, mass production and market release – common terminologies. **PRE-SILICON PROCESSES:** Requirement identification – IC generations – RTL Design – tools and processes – HDLs – design verification processes – design data sheet. **SILICON FABRICATION:** Fabrication process basic overview – wafer manufacturing, oxidation, photolithography, etching, deposition & ion implantation, metal wiring, EDS, packaging – wafer level testing – IC packaging types, **POST-SILICON LAB PROCESSES:** Lab validation process – environment, processes, and tools – wakeup, debug, characterization, compliance testing – test bench, test plans, test programs and automation – instruments in lab validation – final datasheet. **SILICON PRODUCTION AND RELEASE:** Mass Production – production testing – environment, processes, and tools – ATEs – Market release – Evaluation GUIs – Version upgrades Summary – the importance of design, instrumentation, GUIs, and data at different stages – role of Electronics engineers in the processes.

Total: 15 Hours

Reference(s)

1. Semiconductor Manufacturing Handbook by Hwaiyu Geng
2. Semiconductor Devices: Physics and Technology by S. M. Sze and Kwok K. Ng
3. Introduction to Semiconductor Manufacturing Technology by Hong Xiao

22EC0XH GENERATIVE AI **1 0 0 1**

Course Objectives

- To understand simple and complex algorithms involved in NLP and computer vision.
- To create real-world applications based on the latest recent models like chatbot.

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.

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.

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

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Develop practical skills in implementing generative models using deep learning frameworks.
2. Construct & train supervised machine learning models based on the text and image.
3. Develop students' critical thinking skills to analyze and solve problems related to generative I.

Articulation Matrix

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

BASIC TO LATEST MODEL IN THE EVALUATION OF GENERATIVE AI
Basic of NLP - BOG, TFIDF, Word2Vec, Bert, GPT. Basic of Computer Vision - Pixel, CNN, GAN. Large Language model, Image Generation model, Open model- Google Text-to-Text Transfer Transformer (T5), Bidirectional Encoder Representations from Transformers (BERT), llama, mistral. API model - openai, Gemini, amazon bedrock

Total: 15 Hours

Reference(s)

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.

22EC0XI FROM CONCEPT TO PROTOTYPE PCB ELECTRONIC DESIGN ESSENTIALS **1 0 0 1**

Course Objectives

- To Transform the circuit ideas into Electrical/Electronic Circuits and to convert circuits into Single and Multi-layer PCB.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

Course Outcomes (COs)

1. Design, simulate and lay out the electronic circuits using PCB Design Software.
2. Analyze a single-layer and multilayer PCB design.
3. Assess and Test a PCB for Single layer PCB Prototype.

Articulation Matrix

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

PCB DESIGN AND PROTOTYPING

Types of PCB & Single Page Schematic Design - Multipage Schematic Design - Mounting Technologies and Single Layer (TH) Component Placement - Single Layer Through Hole (TH) Routing - Single Layer Surface Mount Device (SMD) Component Placement and Routing – Multi-Layer Through Hole (TH) Component Placement - Multi-Layer Through Hole (TH) Routing.**PCB DESIGN AND PROTOTYPING** Prototyping, Assembling & Soldering of single-layer PCB Board.

Total: 15 Hours

Reference(s)

1. Jon Varteresian, Fabricating Printed Circuit Boards, Newnes, 2002
2. R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill 2001
3. Mark Madou, Fundamentals of Microfabrication, CRC Press, ISBN: 0-8493-9451-1.

22EC0XJ PROTOCOLS IN AUTOMOTIVE COMMUNICATION TECHNOLOGIES

1 0 0 1

Course Objectives

- Explore the fundamental concepts of communication protocols.
- Analyse the key features and characteristics of UART communication.
- Understand the benefits and limitations of using SENT in automotive applications.

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.

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.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.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Analyze the physical layer of CAN, including bit timing and signal levels.
2. Compare UART to other serial protocols (e.g., SPI, I2C).
3. Analyse the key components of an OBD-II system, including the Data Link Connector (DLC) and Electronic Control Unit (ECU).

Articulation Matrix

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

CAN, UART, AND SPI PROTOCOLS
CAN (Hands-on): Gain insights into the CAN protocol, covering frame formats, understanding CAN nodes, signaling, bus states, bit timing calculation, and networking with transceivers. Explore the bx CAN peripheral of STM32, including self-testing modes and block diagrams. UART Protocols (Hands-on): Understand UART, its functionality, and programming aspects. SPI Communication (Hands-on): Explore SPI, its working principles, and programming with a focus on interfacing with MEMS accelerometer sensors. **MOST IN AUTOMOTIVE CONNECTIVITY** MOST Architecture - Communication Protocols in MOST - MOST Interfaces and Components OBD-II: Overview of OBD-II - OBD-II Communication Protocols - OBD-II Scanning Tools-Implementation of OBD-II in Vehicles SENT Protocols: Introduction to SENT - SENT Frame Structure - SENT Communication Protocol Features - Application of SENT in Automotive Systems.

Total: 15 Hours

Reference(s)

1. Bosch CAN Specification: http://esd.cs.ucr.edu/webres/can20.pdf
2. CAN Bus for Beginners: https://www.ti.com/lit/gpn/SN65HVDA1040A-Q1
3. Texas Instruments SPI Resources: https://www.ti.com/video/6245520669001
4. OBD-I & OBD-II: A Complete Guide to Diagnosis, Repair, & Emissions Compliance by Greg Banish. Automotive Ethernet Handbook by Claus Bode
5. Controller Area Network (CAN) Buses and Arbitration Schemes by Georg Jung.

22EC0XK PHYSICAL COMPUTING WITH UNITY AND CONTROLLER

1 0 0 1

Course Objectives

- To understand the integration of Unity3D and Controller for interactive applications.
- To create interactive simulations and games with real-world inputs.

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.

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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

Course Outcomes (COs)

1. Develop proficiency in using Unity, including creating and manipulating 3D objects, scripting with C#, and working with GameObjects and components.
2. Design and implement interactive applications that combine Unity's graphics and Arduino's real-world interactions.
3. Apply advanced Arduino programming techniques to extend the capabilities of Unity and Arduino integration.

Articulation Matrix

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

BUILDING INTERACTIVE APPLICATIONS WITH UNITY AND ARDUINO

Overview of Arduino platform, Understanding Arduino board and components, Introduction to Unity game development engine, Unity interface and project setup, Understanding Game Objects, components, and scripts, Creating and manipulating 3D objects in Unity, Introduction to Unity scripting with C#, Overview of communication protocols (UART, I2C, SPI), Establishing a serial connection between Arduino and Unity, Data transmission and synchronization techniques, Sending and receiving data between Arduino and Unity, Introduction to various sensors (e.g., temperature, light, proximity), Connecting sensors to Arduino and reading sensor data, Processing sensor data in Arduino, Sending sensor data to Unity for visualization and interaction, Planning and designing interactive applications, Integrating multiple Arduino devices with Unity, Implementing user input and feedback mechanisms, Optimizing performance and responsiveness.

Total: 15 Hours

Reference(s)

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.