



VELAMMAL

COLLEGE OF ENGINEERING & TECHNOLOGY, MADURAI – 625 009
(Autonomous)

(Accredited by NAAC with 'A' Grade and by NBA for 6 UG Programmes)

(Approved by AICTE and affiliated to Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM and SYLLABUS

(I to VIII Semesters)

GOLDEN GOALS OF VET

1. Regularity & Punctuality.
2. Nil Failures, High Subject Average & More Centums.
3. Research & Development.
4. Focus in General Knowledge & Depth in the Subject.
5. Communication Skills (Spoken English & Learning more Languages).
6. Extracurricular Activities & Co-Curricular Activities (All-around Development).
7. Good Health and Food Habits.
8. Human Values.

VISION AND MISSION OF THE INSTITUTE

VISION OF VCET

To emerge and sustain as a center of excellence for technical and managerial education upholding social values.

MISSION OF VCET

Our aspirants are

- Imparted with comprehensive, innovative and value – based education.
- Exposed to technical, managerial and soft skill resources with emphasis on research and professionalism.
- Inculcated with the need for a disciplined, happy, married and peaceful life.

VISION AND MISSION OF ECE DEPARTMENT

VISION

To emerge as a vibrant centre of repute, moulding students to excel in Electronics and Communication Engineering with ethical responsibility.

MISSION

To excel in producing competent Electronics and Communication Engineering professionals by

- Imparting strong theoretical background in the fundamental concepts.
- Providing self directed learning opportunities to meet a variety of career choices.
- Training students to realize ethical and environmental responsibilities for the betterment of mankind.
- Entailing the students in Research and Development activities.



**VELAMMAL COLLEGE OF ENGINEERING AND TECHNOLOGY,
VIRAGANOOR, MADURAI-625009
(AUTONOMOUS)**



B. E. ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM

REGULATIONS 2021

CURRICULUM FOR SEMESTERS I TO VIII

SEMESTER I

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
1.	21IP101	Induction Programme (Common to all B.E./B.Tech. Programmes)	-	-	-	-	0
THEORY							
2.	21EN101	Professional English- I (Common to all B.E./B.Tech. Programmes)	HS	3	2	0	4
3.	21MA101	Matrices and Calculus (Common to all B.E./B.Tech. Programmes)	BS	3	2	0	4
4.	21PH101	Engineering Physics (Common to all B.E./B.Tech. Programmes)	BS	3	0	0	3
5.	21CH101	Engineering Chemistry (Common to all B.E./B.Tech. Programmes)	BS	3	0	0	3
6.	21CS101	Problem Solving and Python Programming (Common to all B.E./B.Tech. Programmes)	ES	3	0	0	3
7.	21TA102	Heritage of Tamils / தமிழ் மரபு	HS	1	0	0	1
PRACTICAL COURSES							
8.	21CS102	Problem Solving and Python Programming Laboratory (Common to all B.E./B.Tech. Programmes)	ES	0	0	4	2
9.	21PC101	Physics and Chemistry Laboratory (Common to all B.E./B.Tech. Programmes)	BS	0	0	4	2
TOTAL CREDITS							22

SEMESTER II

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21EN102	English–II (Common to all B.E./B.Tech. Programmes)	HS	3	0	0	3
2.	21MA103	Sampling Techniques and Numerical Methods (Common to B.E. (ECE & CSE) /B.Tech. (IT) Programmes)	BS	3	2	0	4
3.	21PH104	Physics for Electronics Engineering	BS	3	0	0	3
4.	21ME101	Engineering Graphics (Common to all B.E./B.Tech. Programmes)	ES	2	0	2	3
5.	21EC101	Electronic Devices	PC	3	0	0	3
6.	21EC102	Circuit Analysis	PC	3	0	0	3
7.	21CS105	C Programming	ES	2	0	0	2
8.	21TA102	Tamils and Technology/ தமிழரும் தொழில்நுட்பமும்	HS	1	0	0	1
PRACTICAL COURSES							
9.	21EM101	Engineering Practices Laboratory (Common to all B.E./B.Tech. Programmes)	ES	0	0	4	2
10.	21EC103	Electronic Devices and Circuits Laboratory	PC	0	0	4	2
TOTAL CREDITS							26

SEMESTER III

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21MA201	Transforms and Partial Differential Equation (Common to B.E. (CIVIL Engg, ECE & MECH Engg) Programmes)	BS	3	2	0	4
2.	21EC201	Digital Principles and System Design (Common to B.E. (ECE & CSE) /B.Tech. (IT) Programmes)	PC	3	0	0	3
3.	21EC202	Electronic Circuits I	PC	3	0	0	3
4.	21EC203	Signals and Systems	PC	3	0	0	3
5.	21CS214	Object Oriented Programming and Data Structures	ES	3	0	0	3
THEORY WITH PRACTICAL COURSE							
6.	21EC204	Linear Integrated Circuits	PC	3	0	2	4
PRACTICAL COURSES							
7.	21EC205	Analog and Digital Circuits Laboratory	PC	0	0	4	2
8.	21CS215	Object Oriented Programming Laboratory	ES	0	0	4	2
TOTAL CREDITS							24

SEMESTER IV

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21MA206	Probability and Random Processes	BS	3	2	0	4
2.	21CH103	Environmental Science (Common to all B.E./B.Tech. Programmes)	BS	2	0	0	2
3.	21EC206	Electronic Circuits II	PC	3	0	0	3
4.	21EC207	Electromagnetic Fields	PC	3	0	0	3
5.	21EC208	Microprocessors and Microcontrollers	PC	3	0	0	3
THEORY WITH PRACTICAL COURSE							
6.	21EC209	Analog Communication	PC	3	0	2	4
PRACTICAL COURSES							
7.	21EC210	Circuit Design and Simulation Laboratory	PC	0	0	4	2
8.	21EC211	Microprocessors and Microcontrollers Laboratory	PC	0	0	4	2
TOTAL CREDITS							23

SEMESTER V

SEMESTER V							
Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21EC301	Digital Communication	PC	3	0	0	3
2.	21EC302	Transmission Lines and RF Systems	PC	2	2	0	3
3.	21PECXX	Professional Elective I	PE	3	0	0	3
4.	21PECXX	Professional Elective II	PE	3	0	0	3
5.	21MCC01	Constitution of India	MC	2	0	0	0
THEORY WITH PRACTICAL COURSE							
6.	21EC303	Digital Signal Processing	PC	3	0	2	4
PRACTICAL COURSES							
7.	21EN301	Professional Communication Laboratory (Common to all B.E./B.Tech. Programmes)	HS	0	0	2	1
8.		Internship*	EE	0	0	0	1
TOTAL CREDITS							18

SEMESTER VI

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21EC304	Antennas and Wave Propagation	PC	2	2	0	3
2.	21EC305	VLSI and Chip Design	PC	3	0	0	3
3.	21OECXX	Open Elective I	OE	3	0	0	3
4.	21OECXX	Open Elective II	OE	3	0	0	3
5.	21MCC02	Essence of Indian Traditional Knowledge	MC	2	0	0	0
THEORY WITH PRACTICAL COURSE							
6.	21EC306	Communication Networks	PC	3	0	2	4
PRACTICAL COURSE							
7.	21EC307	VLSI Design Laboratory	PC	0	0	4	2
TOTAL CREDITS							18

SEMESTER VII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21EC401	Microwave and Optical Engineering	PC	3	0	0	3
2.	21PECXX	Professional Elective III	PE	3	0	0	3
3.	21PECXX	Professional Elective IV	PE	3	0	0	3
4.	21XXXXX	Open Elective III	OE	3	0	0	3
5.	21XXXXX	Open Elective IV	OE	3	0	0	3
6.	21OCECXX	One Credit Course	OC	0	0	2	1
PRACTICAL COURSES							
7.	21EC403	Microwave and Optical Laboratory	PC	0	0	4	2
8.	21EC404	Project Work I	EE	0	0	4	2
TOTAL CREDITS							20

SEMESTER VIII

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PECXX	Professional Elective V	PE	3	0	0	3
2.	21PECXX	Professional Elective VI	PE	3	0	0	3
PRACTICAL COURSE							
3.	21EC405	Project Work II	EE	0	0	20	10
TOTAL CREDITS							16

*** Industrial training for a period of minimum 2 weeks during the summer / winter vacation.**

Total Credits: 167

SEMESTERWISE CREDIT DISTRIBUTION

Sem./Cat.	I	II	III	IV	V	VI	VII	VIII	Total Credits
HS	5	4	-	-	1	-	-	-	10
BS	12	7	4	6	-	-	-	-	29
ES	5	7	5	-	-	-	-	-	17
PC	-	8	15	17	10	12	5	-	67
PE	-	-	-	-	6		6	6	18
OE	-	-	-	-	-	6	6	-	12
EE	-	-	-	-	1		2	10	14
MC					√	√			-
OC							1		1
Total	22	26	24	23	18	18	20	16	167

Sl. No.	Category	Type of Course
1.	HS	Humanities and Social Sciences including Management
2.	BS	Basic Sciences
3.	ES	Engineering Sciences including workshop, drawing, basics of electrical/mechanical/computer etc.
4.	PC	Professional Core Courses
5.	PE	Professional Elective : Courses relevant to chosen specialization/ branch
6.	OE	Open Electives : Courses from other technical and/or emerging courses
7.	EE	Employability Enhancement Courses: Project Work, Seminar and Internship in Industry
8.	MC	Mandatory Courses
9.	OC	One Credit Courses

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL – I

RF CIRCUITS AND ANTENNA DESIGN

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC01	RF Transceivers	PE	2	2	0	3
2.	21PEC02	RF MEMS	PE	3	0	0	3
3.	21PEC03	RF Test and Measurement	PE	3	0	0	3
4.	21PEC04	Electromagnetic Interference and Compatibility	PE	3	0	0	3
5.	21PEC05	Electromagnetic Metamaterials	PE	2	2	0	3
6.	21PEC06	Modern Antenna Design	PE	2	2	0	3
7.	21PEC07	Signal Integrity	PE	3	0	0	3

VERTICAL – II

SIGNAL AND IMAGE PROCESSING

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC08	Stochastic Digital Signal Processing	PE	2	2	0	3
2.	21PEC09	Digital Image Processing	PE	2	2	0	3
3.	21PEC10	Speech Processing	PE	3	0	0	3
4.	21PEC11	Software Defined Radio	PE	3	0	0	3
5.	21PEC12	DSP Architecture and Programming	PE	3	0	0	3
6.	21PEC13	Wavelets and Multi Resolution Transforms	PE	2	2	0	3
7.	21PEC14	Multimedia Compression Techniques	PE	3	0	0	3

VERTICAL – III

BIO MEDICAL TECHNOLOGIES

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC15	Wearable Devices	PE	3	0	0	3
2.	21PEC16	Human Assist Devices	PE	3	0	0	3
3.	21PEC17	Therapeutic Equipments	PE	3	0	0	3
4.	21PEC18	Medical Imaging Systems	PE	3	0	0	3
5.	21PEC19	Human Computer Interface	PE	3	0	0	3
6.	21PEC20	Wireless Body Area Networks	PE	3	0	0	3
7.	21PEC21	Bio MEMS	PE	3	0	0	3

VERTICAL – IV

EMBEDDED SYSTEMS AND IoT

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC22	Wireless Sensor Networks	PE	3	0	0	3
2.	21PEC23	MEMS Design	PE	2	2	0	3
3.	21PEC24	Embedded and Real Time Systems	PE	3	0	0	3
4.	21PEC25	IoT Based System Design	PE	2	2	0	3
5.	21PEC26	Control Systems for IoT Applications	PE	2	2	0	3
6.	21PEC27	Industrial IoT and Industry 4.0	PE	3	0	0	3
7.	21PEC28	IoT for Smart Systems	PE	3	0	0	3

VERTICAL – V**SPACE TECHNOLOGIES**

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC29	Satellite Communication	PE	3	0	0	3
2.	21PEC30	Avionics	PE	3	0	0	3
3.	21PEC31	Positioning and Navigation Systems	PE	3	0	0	3
4.	21PEC32	Radar Technologies	PE	3	0	0	3
5.	21PEC33	Remote Sensing	PE	3	0	0	3
6.	21PEC34	Unmanned Aerial Vehicles and Drones	PE	3	0	0	3
7.	21PEC35	Rocketry and Space Mechanics	PE	3	0	0	3

VERTICAL – VI**MOBILE AND HIGH SPEED COMMUNICATIONS**

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC57	Mobile Communication	PE	3	0	0	3
2.	21PEC36	Wireless Communication	PE	3	0	0	3
3.	21PEC37	Wireless Broad Band Networks	PE	3	0	0	3
4.	21PEC38	4G/5G Communication Networks	PE	3	0	0	3
5.	21PEC39	Cognitive Radio Networks	PE	3	0	0	3
6.	21PEC40	Space Time Wireless Communication	PE	2	2	0	3
7.	21PEC41	Massive MIMO Systems	PE	3	0	0	3
8.	21PEC42	Millimeter Wave Communication	PE	3	0	0	3

VERTICAL – VII

SEMICONDUCTOR CHIP DESIGN AND TESTING

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC43	Wide Bandgap Devices	PE	3	0	0	3
2.	21PEC44	ASIC Design	PE	3	0	0	3
3.	21PEC45	Low Power IC Design	PE	3	0	0	3
4.	21PEC46	Design for Testability of VLSI Circuits	PE	3	0	0	3
5.	21PEC47	Mixed Signal IC Design	PE	3	0	0	3
6.	21PEC48	System on Chip	PE	3	0	0	3
7.	21PEC49	Network on Chip	PE	3	0	0	3

VERTICAL – VIII

COMPUTATIONAL INTELLIGENCE

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
THEORY							
1.	21PEC50	Artificial Intelligence	PE	2	2	0	3
2.	21PEC51	Pattern Recognition	PE	3	0	0	3
3.	21PEC52	Soft Computing Techniques	PE	2	2	0	3
4.	21PEC53	Machine Learning	PE	2	2	0	3
5.	21PEC54	Deep Learning Techniques	PE	2	2	0	3
6.	21PEC55	Digital Forensics	PE	3	0	0	3
7.	21PEC56	Swarm Intelligence	PE	3	0	0	3

LIST OF MINOR DEGREE COURSES

(Offered by Department of ECE)

EMBEDDED SYSTEMS AND IOT (ES & IoT)

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
1.	21PEC58	Microcontrollers and Embedded C Programming	PE	2	0	2	3
2.	21PEC59	Embedded System using ARM Cortex	PE	3	0	0	3
3.	21PEC60	Ubiquitous Sensing, Computing and Communications	PE	3	0	0	3
4.	21PEC61	Embedded Systems for Biomedical Applications	PE	3	0	0	3
5.	21PEC62	Smart System Automation	PE	2	0	2	3
6.	21PEC63	Introduction to IoT and its Applications	PE	2	0	2	3
7.	21PEC64	Data Analytics for IoT	PE	3	0	0	3
8.	21PEC65	IoT and Edge Computing	PE	3	0	0	3
9.	21PEC66	IoT for Smart Agriculture	PE	3	0	0	3
10.	21PEC67	IoT for Smart Cities	PE	3	0	0	3
11.	21PEC68	IoT for Manufacturing	PE	3	0	0	3

LIST OF ONE CREDIT COURSES

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS
				L	T	P	
1.	21OCEC01	A Practical Course on Communication Systems – Signal Generation and Analysis	OC	0	0	2	1
2.	21OCEC02	A Practical Course on RF Measurements	OC	0	0	2	1
3.	21OCEC03	A Practical Course on Antenna Design and Simulation	OC	0	0	2	1
4.	21OCEC04	A Practical Course on Embedded Systems	OC	0	0	2	1
5.	21OCEC05	A Practical Course on UAV System Design	OC	0	0	2	1
6.	21OCEC06	Artificial Neural Networks – A Practical Approach	OC	0	0	2	1
7.	21OCEC07	Remote Sensing Image Analysis using ENVI Package	OC	0	0	2	1
8.	21OCEC08	Arduino for Engineers	OC	0	0	2	1
9.	21OCEC09	IoT for Healthcare Monitoring	OC	0	0	2	1
10.	21OCEC10	Wearable Devices for Medical Applications	OC	0	0	2	1
11.	21OCEC11	Design Thinking	OC	1	0	0	1
12.	21OCEC12	Emotional Intelligence	OC	1	0	0	1
13.	21OCEC13	Cloud Computing & Wireless Networking	OC	1	0	0	1
14.	21OCEC14	Network Security	OC	1	0	0	1

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(AUTONOMOUS)**

REGULATIONS - 2021

**B. E. ELECTRONICS AND COMMUNICATION ENGINEERING
(CHOICE BASED CREDIT SYSTEM)**

SYLLABUS FOR SEMESTER I TO VIII

SEMESTER I

21IP101	INDUCTION PROGRAMME <i>(Common to all B.E./B.Tech. Programmes)</i>	L	T	P	C
		0	0	0	0
This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over. The induction programme has been introduced by AICTE with the following objective: “Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, as a citizen and as a human being. Besides the above, several meta-skills and underlying values are needed.” “One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “ The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program. (i) Physical Activity This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.					

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in

society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and **therefore there shall be no tests / assessments** during this programme.

REFERENCE:

Guide to Induction program from AICTE

21EN101	PROFESSIONAL ENGLISH-I <i>(Common to all B.E./B.TECH. Programmes)</i>	L	T	P	C
		3	2	0	4
COURSE OBJECTIVES: • To develop learners skills in listening and responding effectively. • To apply basic grammar for better communication. • To employ reading passages for understanding vocabulary. • To construct logical sentences and participate in pair presentation, extempore. • To organize ideas for various compositions in writing.					
UNIT I	INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION				12
Listening – Listening for general information - Specific details - Conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form; Speaking - Self Introduction; Introducing a friend; Conversation - Politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a					

form; Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails; Writing - Writing emails / letters introducing oneself; Grammar - Present Tense (simple, continuous); Question types: Wh/ Yes or No/ and Tags Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).		
UNIT II	NARRATION AND SUMMATION	12
Listening - Listening to podcast, anecdotes / stories / event narration; documentaries and interviews with celebrities; Speaking - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing of documentaries / podcasts/ interviews; Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs; Writing - Guided writing - Paragraph writing Short Report on an event (field trip etc.); Grammar - Past tense (Simple, continuous); Subject-Verb Agreement; and Prepositions; Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.		
UNIT III	DESCRIPTION OF A PROCESS / PRODUCT	12
Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about a products; Speaking - Picture description; Giving instruction to use the product; Presenting a product; and Summarizing a lecture; Reading - Reading advertisements, gadget reviews; user manuals; Writing - Writing definitions; instructions; and Product /Process description; Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect, Present and past perfect continuous tenses; Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words)		
UNIT IV	CLASSIFICATION AND RECOMMENDATIONS	12
Listening - Listening to TED Talks; Scientific lectures; and educational videos; Speaking – Small Talk; Mini presentations and making recommendations; Reading - Newspaper articles; Journal reports - Non Verbal Communication (tables, pie charts etc,) Writing - Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode) Grammar - Articles; Pronouns - Possessive & Relative pronouns; Vocabulary - Collocations; Fixed / Semi fixed expressions		
UNIT V	EXPRESSIONS	12
Listening - Listening to debates/ discussions; different viewpoints on an issue; and panel discussions; Speaking - Group discussions, Debates, and Expressing opinions through Simulations & Role-play; Reading - Reading editorials; and Opinion Blogs; Writing - Essay Writing (Descriptive or narrative); Grammar - Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences; Vocabulary - Cause & Effect Expressions - Content vs. Function words.		

	TOTAL: 60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to: CO1: Listen and comprehend complex academic texts. CO2: Read and infer the denotative and connotative meanings of technical texts. CO3: Write definitions, descriptions, narrations and essays on various topics. CO4: Speak fluently and accurately in formal and informal communicative contexts. CO5: Express their opinions effectively in both oral and written medium of communication.	
TEXT BOOKS: 1. Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University. English for Science & Technology. Cambridge University Press, 2021. 2. Board of Editors, Department of English, Anna University. English for Engineers & Technologists. Orient Blackswan Private Ltd, 2020. 3. Board of Editors, Department of English, Anna University. Using English Orient Blackswan Private Ltd, 2017.	
REFERENCES: 1. Meenakshi Raman & Sangeeta Sharma. Technical Communication – Principles And Practices Oxford University Press, New Delhi, 2016. 2. Lakshminarayanan K.R. A Course Book On Technical English. SciTech Publications (India) Pvt. Ltd., 2012. 3. Ayesha Viswamohan. English For Technical Communication (With CD). McGraw Hill Education, ISBN: 0070264244. 2008. 4. Kulbhusan Kumar, RS Salaria, Effective Communication Skill. Khanna Publishing House. 1st Edition, 2018. 5. Dr. V. Chellammal. Learning to Communicate. Allied Publishing House, New Delhi, 2003.	

21MA101	MATRICES AND CALCULUS (Common to all B.E. / B.Tech. Programmes)	L	T	P	C
		3	2	0	4
COURSE OBJECTIVES: To develop the use of matrix algebra techniques that is needed by engineers for					

practical applications. • To explain the students about differential calculus. • To demonstrate the functions of several variables technique to solve problems in many engineering branches. • To demonstrate the various techniques of integration. • To prepare the student to use mathematical tools in evaluating multiple integrals and their applications.		
UNIT I	MATRICES	12
Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.		
UNIT II	DIFFERENTIAL CALCULUS	12
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.		
UNIT III	FUNCTIONS OF SEVERAL VARIABLES	12
Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange’s method of undetermined multipliers.		
UNIT IV	INTEGRAL CALCULUS	12
Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.		
UNIT V	MULTIPLE INTEGRALS	12
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.		
TOTAL : 60 PERIODS		
COURSE OUTCOMES:		

At the end of the course, learners will be able to

CO1: Use the matrix algebra methods for solving engineering problems.

CO2: Apply differential calculus tools in solving various application problems.

CO3: Make use of differential calculus ideas on several variable functions.

CO4: Identify suitable methods of integration in solving practical problems.

CO5: Solve practical problems of areas, volumes using multiple integrals.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, New Delhi, 2016.
2. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
3. James Stewart, "Calculus: Early Transcendentals", 8th Edition, Cengage Learning, New Delhi, 2015.

REFERENCES:

1. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", 7th Edition, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 2009.
2. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", 5th Edition, Narosa Publications, New Delhi, 2016.
3. Ramana. B.V., "Higher Engineering Mathematics", 6th Edition, McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
4. Thomas. G. B., Hass. J and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

21PH101	ENGINEERING PHYSICS (Common to I Year B.E. / B.Tech. Students)	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To illustrate the students effectively to achieve an understanding of mechanics. • To infer the students to gain knowledge of electromagnetic waves and its applications. • To explain the basics of oscillations, optics and lasers. • To outline the importance of quantum physics.					

To relate the students towards the applications of quantum mechanics.		
UNIT I	MECHANICS	9
Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum– double pendulum –Introduction to nonlinear oscillations.		
UNIT II	ELECTROMAGNETIC WAVES	9
The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.		
UNIT III	OSCILLATIONS, OPTICS AND LASERS	9
Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave – sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference– Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO ₂ laser, semiconductor laser –Basic applications of lasers in industry.		
UNIT IV	BASIC QUANTUM MECHANICS	9
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in an infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.		
UNIT V	APPLIED QUANTUM MECHANICS	9
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		

OUTCOMES:

At the end of the course, learners will be able to:

CO1: Explain the importance of mechanics.

CO2: Extend their knowledge in electromagnetic waves.

CO3: Illustrate a strong foundational knowledge in oscillations, optics and lasers.

CO4: Interpret the importance of quantum physics.

CO5: Summarize quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", First Edition, McGraw Hill Education, 2017.
2. E.M.Purcell and D.J.Morin, "Electricity and Magnetism", Third Edition, Cambridge University Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", Seventh Edition, McGraw-Hill, 2017.

REFERENCES

1. R.Wolfson. "Essential University Physics", Volume 1 & 2. , First Edition (Indian Edition) Pearson Education, 2009.
2. Paul A. Tipler, "Physics"- Volume 1 & 2, First Edition (Indian Edition), CBS Publishers & Distributors, 2004.
3. K.Thyagarajan and A.Ghatak. "Lasers: Fundamentals and Applications", Second Edition, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker, "Principles of Physics", 10th Edition (Indian Edition), Wiley, 2015.
5. N.Garcia, A.Damask and S.Schwarz, "Physics for Computer Science Students", First Edition, Springer Verlag, 2012.

21CH101	ENGINEERING CHEMISTRY (Common to all B.E./B.Tech. Programmes)	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To describe water quality parameters and water treatment techniques. • To discuss basic principles and preparatory methods of nanomaterials. • To demonstrate the basic concepts and applications of phase rule and composites. • To identify different types of fuels, their preparation, properties and combustion characteristics. • To illustrate the operating principles, working processes and applications of energy conversion and storage devices.					
UNIT I	WATER AND ITS TREATMENT				9
Water: Sources and impurities, Water quality parameters: Definition and significance of colour, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.					
UNIT II	NANOCHEMISTRY				9
Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvo thermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.					
UNIT III	PHASE RULE AND COMPOSITES				9
Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.					
Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites					

definition and examples.		
UNIT IV	FUELS AND COMBUSTION	9
Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel. Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO₂ emission and carbon foot print.		
UNIT V	ENERGY SOURCES AND STORAGE DEVICES	9
Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles-working principles; Fuel cells: H₂-O₂ fuel cell, microbial fuel cell; Super capacitors: Storage principle, types and examples.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water. CO2: Describe the basic concepts of nano science and nanotechnology in designing the synthesis of nano materials for engineering and technology applications. CO3: Apply the knowledge of phase rule and composites for material selection requirements. CO4: Identify suitable fuels for engineering processes and applications. CO5: Demonstrate different forms of energy resources and apply them for suitable applications in energy sectors.		
TEXT BOOKS: 1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018. 2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd,		

New Delhi, 2008.

3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

21CS101	PROBLEM SOLVING AND PYTHON PROGRAMMING (Common to all B.E./B.Tech Programmes)	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
• To describe the basics of algorithmic problem solving. • To solve problems using Python conditionals and loops. • To illustrate Python functions and use function calls to solve problems. • To make use of Python data structures - lists, tuples, and dictionaries to represent complex data. • To explain input/output with files in Python.					
UNIT-I	COMPUTATIONAL THINKING AND PROBLEM SOLVING				9
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, and guess an integer number in a range, Towers of Hanoi.					

UNIT-II	DATA TYPES, EXPRESSIONS, STATEMENTS	9
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	CONTROL FLOW, FUNCTIONS, STRINGS	9
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-else-if-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	LISTS, TUPLES, DICTIONARIES	9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.		
UNIT-V	FILES, MODULES, PACKAGES	9
Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).		
TOTAL :45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Use algorithmic solutions to solve simple computational problems. CO2: Develop and execute simple Python programs. CO3: Solve simple programs using conditionals, loops and functions for solving problems. CO4: Construct compound data using Python lists, tuples, dictionaries etc. CO5: Prepare read and write data from/to files in Python programs.		

TEXT BOOKS:

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.
3. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc- Graw Hill, 2018.

REFERENCES:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, 1st Edition, Pearson Education, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", 3rd Edition, MIT Press, 2021.
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019

21CS102	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY <i>(Common to all B.E./B.Tech. Programmes)</i>	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To describe the basics of algorithmic problem solving.
- To solve problems using Python conditionals and loops.
- To illustrate Python functions and use function calls to solve problems.
- To make use of Python data structures - lists, tuples, and dictionaries to represent complex data.
- To explain input/output with files in Python.

LIST OF EXPERIMENTS	
1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.,) 2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points). 3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern) 4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples) 5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.,- operations of Sets & Dictionaries) 6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape) 7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters) 8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy) 9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word) 10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation) 11. Exploring Pygame tool. 12. Developing a game activity using Pygame like bouncing ball, car race etc.,	
	TOTAL:60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Develop algorithmic solutions to solve simple computational problems. CO2: Construct simple Python programs. CO3: Build programs using conditionals, loops and functions for solving problems. CO4: Demonstrate compound data using Python data structures. CO5: Utilize Python packages in developing software applications.	

21PC101	PHYSICS AND CHEMISTRY LABORATORY (Common to all B.E./B.Tech. Programmes)	L	T	P	C
		0	0	4	2
PHYSICS LABORATORY					
COURSE OBJECTIVES:					
- To explain the proper use of various kinds of physics laboratory equipment. - To extend how data can be collected, presented and interpreted in a clear and concise manner. - To infer problem solving skills related to physics principles and interpretation of experimental data. - To summarize error in experimental measurements and techniques used to minimize such error. - To translate the student as an active participant in each part of all lab exercises.					
LIST OF EXPERIMENTS: (Any 7 Experiments)					
- Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects. - Simple harmonic oscillations of cantilever. - Non-uniform bending - Determination of Young's modulus - Uniform bending – Determination of Young's modulus - Laser- Determination of the wave length of the laser using grating - Air wedge - Determination of thickness of a thin sheet/wire a) Optical fibre -Determination of Numerical Aperture and acceptance angle b) Compact disc- Determination of width of the groove using laser. - Acoustic grating- Determination of velocity of ultrasonic waves in liquids. - Ultrasonic interferometer – Determination of the velocity of sound and compressibility of liquids - Post office box - Determination of Band gap of a semiconductor. - Photoelectric effect - Michelson Interferometer. - Melde's string experiment - Experiment with lattice dynamics kit.					
TOTAL: 30 PERIODS					

COURSE OUTCOMES:

At the end of the course, learners will be able to

- CO1: Explain the functioning of various physics laboratory equipment.
- CO2: Relate the graphical models to analyze laboratory data.
- CO3: Interpret mathematical models as a medium for quantitative reasoning and describing physical reality.
- CO4: Explain Access, process and analyze scientific information.
- CO5: Translate students to solve problems individually and collaboratively.

REFERENCES :

1. Physics Laboratory Manual, Department of Physics, Velammal College of Engineering & Technology, Madurai (2021)
2. P. Mani, Physics Laboratory, 1st edition, Dhanam Publications, 2021.

*Each class is divided in to two batches (30 students / batch) and each batch will perform their experiments alternatively per week in physics and chemistry laboratory.

CHEMISTRY LABORATORY**COURSE OBJECTIVES:**

- To identify the required glass wares and instruments for chemical analysis.
- To estimate water quality parameters such as hardness, dissolved oxygen and chloride content.
- To relate electrochemical techniques such as pH metry, conductometry and potentiometry.
- To interpret the data collected from the analysis.
- To express the skills to get accurate results.

LIST OF EXPERIMENTS :**(Any seven experiments to be conducted)**

1. Preparation of Na_2CO_3 as a primary standard and estimation of acidity of a water sample using the primary standard.
2. Determination of types and amount of alkalinity in water sample. -Split the first experiment into two.
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.

5. Determination of chloride content of water sample by Argentometric method. 6. Estimation of copper content of the given solution by Iodometry. 7. Estimation of TDS of a water sample by gravimetry. 8. Determination of strength of given hydrochloric acid using pH meter. 9. Determination of strength of acids in a mixture of acids using conductivity meter. 10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration). 11. Estimation of iron content of the given solution using potentiometer. 12. Estimation of sodium /potassium present in water using flame photometer. 13. Preparation of nanoparticles (TiO ₂ /ZnO/CuO) by Sol-Gel method. 14. Estimation of Nickel in steel. 15. Proximate analysis of Coal.
TOTAL: 30 PERIODS
COURSE OUTCOMES : At the end of the course, learners will be able to CO1: Extent the skills to choose and handle appropriate glass wares. CO2: Interpret the water quality parameters using volumetric method. CO3: Estimate the conductivity, pH & emf by electro chemical methods. CO4: Infer the collected data for appropriate chemical analysis. CO5: Demonstrate systematic approach to obtain accurate results.
TEXT BOOK: 1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

SEMESTER II

21EN102	ENGLISH-II (Common to all B.E./B.TECH. Programmes)	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
To develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.					

• To prepare and write convincing job applications and effective reports. • To demonstrate their speaking skills to make technical presentations and participate in group discussions. • To apply their Listening skill which will help them comprehend lectures and talks in their areas of specialization • To choose appropriate soft skills to suit the situation.		
UNIT I	INTRODUCTION TO TECHNICAL ENGLISH	9
Listening - Factual and Academic speeches; Speaking - Asking for and giving directions - Reading - Technical texts from - Newspapers /websites; Writing - Statements - Definitions - issue based writing instructions - Checklists - Recommendations; Vocabulary Development -technical vocabulary; Grammar - Error spotting - Compound words; Soft skills - Leadership Skills.		
UNIT II	READING AND STUDY SKILLS	9
Listening - Listening to longer technical talks and completing exercises based on them; Speaking - Describing a general process; Reading - Reading longer technical texts - Identifying the various transitions in a text - Paragraphing; Writing - Interpreting charts, graphs; Vocabulary Development - Vocabulary used in formal letters/emails and reports Grammar - Impersonal passive voice, numerical adjectives - Soft skills - Teamwork		
UNIT III	TECHNICAL WRITING AND GRAMMAR	9
Listening - Listening to classroom lectures, talks on engineering /technology; Speaking - introduction to technical presentations; Reading - longer texts both general and technical, practice in speed reading; Writing - Describing a technical process; Vocabulary Development - Sequence words - Misspelled words; Grammar - Embedded sentences ; Soft skills - Decision making		
UNIT IV	JOB APPLICATIONS	9
Listening - Listening to documentaries and making notes. Speaking - Mechanics of presentations; Reading - Reading for detailed comprehension; Writing - Email etiquette - job application - Cover Letter - Resume preparation(via email and hard copy) - Analytical essay writing - Vocabulary Development - finding suitable synonyms - paraphrasing; Grammar - clauses - If conditionals - Soft skills - Time Management		
UNIT V	GROUP DISCUSSION AND REPORT WRITING	9
Listening - TED talks; Speaking - Participating in a group discussion - Reading - Reading and understanding technical articles; Writing - Writing reports - Survey report, accident report and minutes of a meeting - Vocabulary Development - Verbal analogies; Grammar - reported speech; Soft skills - Conflict Resolution.		

	TOTAL: 45 PERIODS
COURSE OUTCOMES : At the end of the course, learners will be able to: CO1: Interpret by reading information in technical texts CO2: Choose appropriate language to write convincing job applications, resume and reports CO3: Formulate the technical ideas effectively in spoken and written forms CO4: Analyze and understand spoken language in lectures and talks CO5: Demonstrate basic soft skills in life	
TEXT BOOKS: 1. Board of Editors, Fluency in English-A Course book for Undergraduate Engineers and Technologist. Orient Blackswan Pvt Ltd, Hyderabad: 2018 2. Jawahar, Jewelcy & Rathna.P. Communicative English Workbook. VRB Publishers Pvt Ltd. Chennai. 2018. 3. Board of Editors, Department of English, Anna University, Chennai. Mindscapes-English for Technologists and Engineers. Orient Black Swan Pvt Ltd, Chennai, 2012.	
REFERENCES: 1. Verma, Shalini. Technical Communication for Engineers. Vikas Publishing House Pvt Ltd. New Delhi. 2015 2. Raman, Meenakshi & Sharma, Sangeeta. Technical Communication English Skills for Engineers. Oxford University Press. 2008. 3. Rizvi, Ashraf.M. Effective Technical Communication. MC Graw Hill Education Pvt Ltd. New Delhi. 2016.	

21MA103	SAMPLING TECHNIQUES AND NUMERICAL METHODS (Common to all B.E. (ECE & CSE)/B.Tech. (IT) Programmes)	L	T	P	C
		3	2	0	4
COURSE OBJECTIVES:					
• To describe the necessary basic concepts in probability. • To explain the concept of testing of hypothesis for small and large samples which plays an important role in real life problems. • To use the basic concepts of classification of design of experiments. • To choose the method for solving algebraic and transcendental equations using numerical techniques.					

To discuss the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.		
UNIT I	PROBABILITY	12
Introduction-Sample Spaces and Events-Axioms of Probability-Interpretations and Properties of Probabilities-Conditional Probabilities-Bayes's theorem- Independence.		
UNIT II	TESTING OF HYPOTHESIS	12
Large sample test based on Normal distribution for single mean and difference of means – Tests based on t, χ^2 and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.		
UNIT III	DESIGN OF EXPERIMENTS	12
Introduction, aim, basic designs of experiments, one way and two way classifications - Completely randomized design – Randomized block design – Latin square design.		
UNIT IV	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12
Newton Raphson method –Method of False position- pivoting – Gauss Jordan methods – Iterative method: Gauss Seidel – Matrix inversion by Gauss Jordan method – Eigen values of a matrix by power method.		
UNIT V	INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	12
Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's 1/3 rules, 3/8 th rule.		
		TOTAL: 60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Apply the concepts of Probability in Engineering problems. CO2: Explain the test of hypothesis for small and large samples by using various test like t-test, F-test, Z-test and χ^2 test. CO3: Apply the basic concepts of classifications of design of experiments. CO4: Solve the system of equations and the eigen value problems using iterative procedure.		

CO5: Calculate the value of an unknown function at any interpolated point of the given tabulated values.

TEXT BOOKS:

1. JAY.L. Devore, "Probability and Statistics for Engineering and the Science", Ninth Edition, Cengage Learning, 2021.
2. Johnson. R.A., and Irwin Miller, John Freund, "Miller and Freund's Probability and Statistics for Engineers", 12th Edition, Pearson Education, Asia, 2011.
3. Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis", Seventh Edition, Pearson Education, Asia, New Delhi, 2008.

REFERENCES:

1. Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", Eighth Edition, Pearson Education, Asia, 2007.
2. Spiegel. M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Third Edition, Tata McGraw Hill, 2012.
3. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", Fifth Edition, Tata McGraw Hill, New Delhi, 2007.
4. Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", Ninth Edition, Khanna Publishers, New Delhi, 2007.

21PH104	PHYSICS FOR ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To make the students to understand the basics of crystallography and its importance in studying materials properties. • To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials. • To instil knowledge on physics of semiconductors, determination of charge carriers and device applications. • To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications. • To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.					

UNIT I	CRYSTALLOGRAPHY	9
Crystal structures: Crystal lattice - basis - unit cell and lattice parameters -Crystal systems and Bravais lattices - Structure and packing fractions of SC, BCC, FCC structures -Crystal planes, directions and Miller indices -Distance between successive planes -Linear and planar densities - Crystalline and non-crystalline materials - Example use of Miller indices: wafer surface orientation -Wafer flats and notches -Pattern alignment - Imperfections in crystals		
UNIT II	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	9
Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, expression - Quantum free electron theory: tunneling -Degenerate states - Fermi-Dirac statistics Density of energy states - Electron effective mass -Concept of hole. Magnetic materials: dia, para and ferromagnetic effects -Domain theory of ferromagnetism-M–H curve -Quantum interference devices - GMR devices.		
UNIT III	SEMICONDUCTORS AND TRANSPORT PHYSICS	9
Intrinsic Semiconductors - Energy band diagram -Direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors -Extrinsic semiconductors - Carrier concentration in n-type &p-type semiconductors - Variation of carrier concentration with temperature - Carrier transport in Semiconductors: Drift, mobility and diffusion - Hall effect and devices - Ohmic contacts - Schottky diode.		
UNIT IV	OPTICAL PROPERTIES OF MATERIALS	9
Classification of optical materials - Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells - Optoelectronic devices: light detectors and solar cells -Light emitting diode -Laser diode - Optical processes in organic semiconductor devices - Excitonic state - Electro-optics and nonlinear optics: Modulators and switching devices.		
UNIT V	NANO DEVICES	9
Density of states for solids - Significance between Fermi energy and volume of the material - Quantum confinement - Quantum structures - Density of states for quantum wells, wires and dots - Band gap of nanomaterials - Tunneling - Single electron phenomena - Single electron Transistor. Conductivity of metallic nanowires - Ballistic transport - Quantum resistance and conductance - Carbon nanotubes: Properties and applications - Spintronic devices and applications - Optics in quantum structures - quantum well laser.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		

At the end of the course, learners will be able to:

CO1: Know basics of crystallography and its importance for varied materials properties.

CO2: Gain knowledge on the electrical and magnetic properties of materials and their applications.

CO3: Understand clearly of semiconductor physics and functioning of semiconductor devices.

CO4: Understand the optical properties of materials and working principles of various optical devices.

CO5: Appreciate the importance of nanotechnology and nano devices.

TEXT BOOKS:

1. S.O. Kasap, Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. R.F.Pierret, Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

REFERENCES:

1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Electrical Properties of Materials, Oxford Univ. Press (Indian Edition) 2015.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Mark Fox, Optical Properties of Solids, Oxford Univ.Press, 2001.
5. N.Gershenfeld. The Physics of Information Technology. Cambridge University Press, 2011.

21ME101	ENGINEERING GRAPHICS (Common to all B.E./B.Tech. Programmes)	L	T	P	C
		2	0	2	3
COURSE OBJECTIVES:					
- To sketch the projection of points, lines and planes. - To sketch the projection of simple solids. - To sketch the projection of sectioned solids and development of lateral surfaces.					

- To sketch the isometric and perspective views of simple solids. - To sketch the orthographic projection of various objects free handly.		
UNIT I	PROJECTIONS OF POINTS, LINES AND PLANE SURFACE	12
Importance of graphics in engineering applications – Use of drafting instruments - Lettering and dimensioning. Introduction to Orthographic projections - Principles -Principal planes-First angle projection. Projection of points located in all quadrants. Projection of straight lines inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (regular polygonal and circular surfaces) inclined to both the principal planes by rotating object method. (Not for Examination)		
UNIT II	PROJECTION OF SOLIDS	12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.		
UNIT III	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	12
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.		
UNIT IV	ISOMETRIC AND PERSPECTIVE PROJECTIONS	12
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method .		
UNIT V	FREEHAND SKETCHING	12
Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects. Introduction to drafting packages and demonstration. (Not for examination).		
TOTAL: 60 PERIODS		
COURSE OUTCOMES:		

At the end of the course, learners will be able to

CO1: Construct the orthographic projections of points, straight lines and plane surfaces.

CO2: Sketch the orthographic projections of simple solids

CO3: Sketch the orthographic projections of sectional solids and lateral surfaces of the solids.

CO4: Construct the isometric projections and perspective projections of simple solids.

CO5: Sketch the orthographic projection of objects using free hand.

TEXT BOOKS:

1. Natarajan K.V., "A text book of Engineering Graphics", 31st Edition, Dhanalakshmi Publishers, Chennai, 2018.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", 15th Edition, New Age International (P) Limited, 2018.
3. Bhatt N.D. and Panchal V.M., "Engineering Drawing", 53rd Edition, Charotar Publishing House, 2014.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", 2nd Edition, Tata McGraw Hill Publishing Company Limited, 2013.
2. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", 2nd Edition, Oxford University, Press, New Delhi, 2015.
3. Shah M.B., and Rana B.C., "Engineering Drawing", 2nd Edition, Pearson, 2009.

21EC101	ELECTRONIC DEVICES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To explain about basic semiconductor diodes, their characteristics and applications. • To impart knowledge on different configurations and models of bipolar junction transistors. • To demonstrate the construction and working principle of field effect transistors. • To infer the operations of special semiconductor devices. • To interpret the theory, construction and operation of power and display devices.					
UNIT I	SEMICONDUCTOR DIODE	9			

PN Junction Diode, Current equations, Energy band diagram, Diffusion and Drift current densities, Forward and Reverse bias characteristics, Transition and Diffusion capacitances, Switching characteristics, Breakdown in PN Junction Diodes.		
UNIT II	BIPOLAR JUNCTION TRANSISTORS	9
NPN -PNP -Operations - Early effect - Current equations – Input and Output characteristics of CE,CB, CC - Hybrid - π model - h-parameter model, Ebers Moll model.		
UNIT III	FIELD EFFECT TRANSISTORS	9
JFETs – Drain and Transfer characteristics - Current equations - Pinch off voltage and its significance – MOSFET - Characteristics - Threshold voltage - Channel length modulation, D-MOSFET, E-MOSFET- Characteristics – Comparison of MOSFET with JFET.		
UNIT IV	SPECIAL SEMICONDUCTOR DEVICES	9
Metal semiconductor junction - MESFET, FINFET, DUAL GATE MOSFET, Schottky barrier diode - Zener diode - Varactor diode - Tunnel diode - Gallium Arsenide diode, LASER diode and LDR.		
UNIT V	POWER DEVICES AND DISPLAY DEVICES	9
UJT, SCR, DIAC, TRIAC, Power BJT- Power MOSFET- DMOS – VMOS, LED, LCD, Photo transistor, Opto coupler, Solar cell and CCD.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Explain the operation and characteristics of semiconductor diode. CO2: Outline the construction and working of bipolar junction transistors. CO3: Explain the construction and characteristics of field effect transistors devices. CO4: Summarize the working principles of special semiconductor devices. CO5: Illustrate the construction and working of power & display devices.		
TEXT BOOKS: 1. Donald A Neaman, “Semiconductor Physics and Devices”, 4 th Edition, Tata Mc GrawHill Inc, 2012. 2. Salivahanan. S, Suresh Kumar. N, Vallavaraj. A, “Electronic Devices and Circuits”, 3 rd Edition, Tata McGraw-Hill, 2008.		

3. David A. Bell, "Electronic Devices and Circuits", 5 th Edition, Oxford Higher education press 2010.
REFERENCES:
1. Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory", 10 th Edition, Pearson Prentice Hall, July 2008.
2. R. S. Sedha, "A Text Book of Applied Electronics", S.Chand Publications, 2006.
3. Yang, "Fundamentals of Semiconductor Devices", McGraw Hill International Edition, 1978.

21EC102	CIRCUIT ANALYSIS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To outline the basic concepts and behaviour of DC and AC circuits. • To infer about various methods of circuit/ network analysis using network theorems. • To summarize the steady state response of the circuits subject to DC excitations and AC with sinusoidal excitations. • To become familiar in transient response of the circuits subject to DC excitations and AC with sinusoidal excitations. • To gain knowledge on the concept of coupling in circuits and topologies.					
UNIT I	DC CIRCUIT ANALYSIS	9			
Basic components of Electric circuits, Charge, Current, Voltage and Power, Voltage and Current sources, Ohms law, Kirchoff's current law, Kirchoff's voltage law, The single Node – Pair circuit, Series and Parallel connected independent sources, Resistors in series and parallel, Voltage and Current division, Nodal analysis and Mesh analysis.					
UNIT II	NETWORK THEOREM FOR DC CIRCUITS AND DUALITY	9			
Circuit analysis techniques - Linearity and Superposition, Thevenin and Norton equivalent circuits, Maximum power transfer, Delta-Wye conversion, Duality, Dual circuits, Analysis using dependent current sources and voltage sources.					
UNIT III	SINUSOIDAL STEADY STATE ANALYSIS	9			

Sinusoidal steady – state analysis, Characteristics of sinusoids, Nodal and Mesh analysis, Circuit analysis techniques - Linearity and Superposition, Thevenin and Norton equivalent circuits, Maximum power transfer - AC circuit power analysis, Instantaneous power and Average power.		
UNIT IV	TRANSIENTS AND RESONANCE IN RLC CIRCUITS	9
Basic RL and RC circuits, The source - free RL circuit, The source-free RC Circuit, The Unit-Step function, Driven RL circuits, Driven RC circuits, RLC circuits, Frequency response, Parallel resonance, Series resonance and Quality factor.		
UNIT V	COUPLED CIRCUITS AND TOPOLOGY	9
Magnetically coupled circuits, Mutual inductance, Linear transformer, Ideal transformer, An introduction to Network topology, Trees and General nodal analysis, Links and Loop analysis.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Make use of the basic voltage and current laws for analysis of DC and AC circuits. CO2: Select suitable network theorems to analyze DC and AC circuits. CO3: Examine the steady state response of R, L and C circuits. CO4: Identify the transient and frequency response of RLC circuits. CO5: Solve the various parameters of coupled circuits and infer the network topologies.		
TEXT BOOKS: 1. Hayt Jack Kemmerly and Steven Durbin, "Engineering Circuit Analysis", 9 th Edition, Mc Graw Hill, 2018. 2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", 2 nd Edition, Mc Graw - Hill, 2003. 3. Joseph Edminister and Mahmood Nahvi, "Electric Circuits, Schaum's Outline Series", 5 th Edition, Tata McGraw Hill Publishing Company, New Delhi, Reprint 2016.		
REFERENCES: 1. Robert.L. Boylestead, "Introductory Circuit Analysis", 12 th Edition, Pearson Education India, 2014. 2. David Bell, "Fundamentals of Electric Circuits", 7 th Edition, Oxford University press, 2009. 3. John O Mallay, "Basic Circuit Analysis", 2 nd Edition, Schaum's Outlines, Mc Graw		

Hill, 2011.

4. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", 5th Edition, Cengage Learning, 1st Indian Reprint 2013.

21CS105	C PROGRAMMING	L	T	P	C
		2	0	0	2
COURSE OBJECTIVES : • To describe the basic programming principles of C language. • To choose a suitable C-construct to develop C code for a given problem. • To use the C-language syntax rules to correct the bugs in the C program. • To develop simple C programs to illustrate the applications of different data types such as arrays, pointers, functions. • To illustrate the concepts of Structures and Unions.					
UNIT I	BASICS OF C PROGRAMMING	6			
Introduction to C- Structure of a C Program- Compiling and Executing C Programs- C tokens- Input/Output Statements in C- Operators in C- Type Conversion and Typecasting					
UNIT II	DECISION CONTROL AND LOOPING STATEMENTS	6			
Decision Control Statements- Conditional Branching Statements- Iterative Statements- Nested Loops- Break and Continue Statements- Goto Statement					
UNIT III	ARRAYS AND STRINGS	6			
Introduction to Arrays: Declaration, Accessing the Elements of an Array - Storing Values in Arrays Operations on Arrays - Two dimensional arrays - String operations					
UNIT IV	FUNCTIONS AND POINTERS	6			
Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion. Pointers – Declaring Pointer Variables- Pointer Expressions and Pointer Arithmetic -Null Pointers – Parameter passing: Pass by value, Pass by reference					
UNIT V	STRUCTURES AND UNION	6			

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation– Union
TOTAL: 30 PERIODS
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Develop simple applications using basic C components. CO2: Build applications adopting array and string concepts. CO3: Develop and implement applications in C using functions and pointers. CO4: Build applications in C by employing structure and union concepts. CO5: Design simple applications that make use of C construct.
TEXT BOOKS: 1. ReemaThareja, “Programming in C”, Oxford University Press, 2nd Edition, 2016. 2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, 2nd Edition, Pearson Education, 2015. 3. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013
REFERENCES: 1. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018. 2. YashwantKanetkar, Let us C, 17th Edition, BPB Publications, 2020. 3. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996. 4. PradipDey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.

21EM101	ENGINEERING PRACTICES LABORATORY (Common to all B.E / B.Tech. Programmes)	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES:					
- To draw pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work. - To demonstrate the basic switch board wiring, fluorescent lamp wiring and stair case wiring using various electrical components. - To choose various joints in steel plates using arc welding work and machining various simple processes like turning, drilling, tapping in parts. - To build a tray out of metal sheet using sheet metal work. - To develop electronic circuit and testing for soldering and desoldering using PCB board.					
LIST OF EXPERIMENTS:					
GROUP – A (CIVIL & ELECTRICAL)					
PART – I					
CIVIL ENGINEERING PRACTICES PLUMBING WORK: - Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household. - Preparing plumbing line sketches. - Laying pipe connection to the suction side of a pump - Laying pipe connection to the delivery side of a pump. - Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances. WOOD WORK: - Sawing, - Planning and Making joints like T-Joint, Cross lap and Dovetail joint.					

PART – II
ELECTRICAL ENGINEERING PRACTICES • Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket • Staircase wiring • Fluorescent Lamp wiring with introduction to CFL and LED types. • Energy meter wiring and related calculations/ calibration • Study of Iron Box wiring and assembly • Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac) • Measurement of resistance to earth of an electrical equipment.
GROUP – B (MECHANICAL & ELECTRONICS)
PART III
MECHANICAL ENGINEERING PRACTICES WELDING WORK: • Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. • Practicing gas welding. BASIC MACHINING WORK: • Usage of Spanners and screw drivers • Facing and Turning. • Taper Turning ASSEMBLY WORK: • Assembling a centrifugal pump. • Assembling a household mixer. • Assembling an air conditioner. SHEET METAL WORK: • Making of a square tray FOUNDRY WORK: • Demonstrating basic foundry operations.
PART IV
ELECTRONIC ENGINEERING PRACTICES SOLDERING WORK: • Soldering simple electronic circuits and checking continuity. ELECTRONIC ASSEMBLY AND TESTING WORK: • Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:	
• Study elements of smart phone. • Assembly and dismantle of computer / laptop	
TOTAL: 45 PERIODS	
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Build various plumbing joints. CO2: Develop various carpentry joints. CO3: Construct various wiring electrical joints in common household electrical wire work. CO4: Construct various welded joints, sheet metal and basic machining operations. CO5: Develop the electronic circuit for soldering and testing using PCB board.	

21EC103	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES : • To gain knowledge about KVL, KCL, Thevenin, Norton and Superposition theorems. • To study the transient analysis of RLC circuits. • To infer the characteristics of Diode. • To summarize the characteristics of BJT, FET and SCR. • To demonstrate the working principle of half wave and full wave rectifiers.					
LIST OF EXPERIMENTS: 1. Verification of KVL and KCL 2. Verification of Superposition theorem. 3. Verification of Thevenin and Norton theorem. 4. Verification of Maximum power transfer and reciprocity theorem. 5. Determination of Resonance frequency of series and parallel RLC Circuits. 6. Characteristics of PN Junction diode and Zener diode.					

7. Common Emitter input-output Characteristics. 8. Common Base input-output Characteristics. 9. FET Characteristics. 10. SCR Characteristics. 11. Half-wave rectifier and Full-wave rectifier.
TOTAL: 60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Build circuits to verify Kirchoff's laws and network theorems. CO2: Make use of RLC circuits to determine their frequency response. CO3: Examine the characteristics of PN and Zener diodes. CO4: Compare the characteristics of BJT, FET and SCR. CO5: Distinguish half wave rectifier with full wave rectifier.

SEMESTER III

21MA201	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (Common to B.E.(CIVIL Engg.,ECE & MECH. Engg.) Programmes)	L	T	P	C
		3	2	0	4
COURSE OBJECTIVES:					
- To use various methods of Laplace transforms for efficiently solving the problems that occur in various branches of engineering disciplines. - To identify Fourier series which is essential to many applications in engineering. - To explain the mathematical tools for the solutions of partial differential equations that model several physical processes. - To explain the student with Fourier transform techniques used in wide variety of situations. - To develop Z transform techniques to solve difference equations for discrete time systems.					
UNIT I	LAPLACE TRANSFORM				12

Laplace transform- conditions for existence –Transform of elementary functions –Basic properties –First shifting theorem –Transform of derivatives on $t f(t), f(t)/t$ and periodic functions- Transform of unit step function and impulse functions. Inverse Laplace transform by partial function method and convolution theorem (excluding proof)-Initial and final value theorems-Solutions of linear ODE of second order with constant coefficients using Laplace transform techniques.		
UNIT II	FOURIER SERIES	12
Dirichlet's conditions – General Fourier series odd and even functions – Half range sine series – half range cosine series – Parseval's identity – Harmonic Analysis.		
UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12
Classifications of PDE – Solutions of one dimensional wave equations – one dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).		
UNIT IV	FOURIER TRANSFORMS	12
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transform – Properties – Transforms of simple functions – convolution theorem – Parseval's identity.		
UNIT V	Z- TRANSFORMS AND DIFFERENCE EQUATIONS	12
Z- Transforms – Elementary properties – Inverse Z- Transforms (Using partial fractions and residues) – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-transforms.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Calculate Laplace transform and inverse Laplace transform of different functions. CO2: Express the Fourier series expansion to represent the given function in the given interval. CO3: Classify the second order PDE and to know about solving initial and final value problems. CO4: Apply Fourier transform techniques to evaluate the given integral. CO5: Solve the given difference equations using Z-transforms.		

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", 10th Edition, John Wiley and Sons, New Delhi, 2016.
2. Peter V.O. Neil "Advanced Engineering Mathematics", 7th Edition, Cengage, New Delhi, 2012.
3. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.

REFERENCES:

1. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", 6th Edition, Tata McGraw-Hill, New Delhi, 2012.
3. Datta K.B., "Mathematical Methods of Science and Engineering", 2nd Edition, Cengage Learning India Pvt Ltd, Delhi, 2013.

21EC201	DIGITAL PRINCIPLES AND SYSTEM DESIGN (Common to B.E. (ECE & CSE) /B.Tech. (IT) Programmes)	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To outline the digital fundamentals, Boolean algebra and its applications in digital systems. • To summarize the design of various combinational digital circuits using logic gates. • To infer the design procedures for synchronous sequential circuits. • To familiarize with the analysis and design procedures for asynchronous sequential circuits. • To explain the various semiconductor memories.					
UNIT I	DIGITAL FUNDAMENTALS	9			
Number systems – Decimal, Binary, Octal, Hexadecimal, 1’s and 2’s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map minimization, NAND and NOR implementations.					

UNIT II	COMBINATIONAL CIRCUIT DESIGN	9
Design of Half and Full adders, Half and Full subtractors, Binary parallel adder – Carry look ahead adder, BCD adder, Multiplexer, Demultiplexer, Magnitude comparator, Decoder, Encoder and Priority Encoder.		
UNIT III	SYNCHRONOUS SEQUENTIAL CIRCUITS	9
Flip flops – SR, JK, T, D, Master / Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - state minimization, state assignment, circuit implementation – Design of Counters- Ripple counters, Ring counters, Shift registers and Universal shift register.		
UNIT IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	9
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Design of Hazard free circuits.		
UNIT V	MEMORY DEVICES AND VERILOG PROGRAMMING	9
Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL. Design of half adder, full adder, flip flops and counters using Verilog.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Make use of minimization techniques to simplify Boolean algebraic equations. CO2: Build various combinational circuits using logic gates. CO3: Develop synchronous sequential circuits using flip flops. CO4:Construct asynchronous sequential circuits using flip flops. CO5: Explain various semiconductor memories and programmable logic devices.		
TEXT BOOKS: 1. M. Morris R. Mano, Michael D. Ciletti, “Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog”, 6 th Edition, Pearson Education, 2017. 2. S.Salivahanan and S.Arivazhagan, “Digital Electronics”, 1 st Edition, Vikas Publishing House pvt Ltd, 2012.		

3. Soumitra Kumar Mandal, “Digital Electronics”, McGraw Hill Education Private Limited, 2016.
REFERENCES: 1. Charles H.Roth, “Fundamentals of Logic Design”, 6th Edition, Thomson Learning, 2013. 2. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, 2011 3. A.Anand Kumar, “Fundamentals of Digital Circuits”, 4th Edition, PHI Learning Private Limited, 2016.

21EC202	ELECTRONIC CIRCUITS I	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To infer the various biasing techniques of BJT. • To summarize the concepts of different biasing techniques of JFET and MOSFET. • To introduce the design procedure of single stage amplifier circuits. • To demonstrate the multistage BJT, FET and MOSFET amplifiers. • To infer the frequency response of small signal amplifiers.					
UNIT I	BIASING OF BJT	9			
BJT– Need for biasing - DC load line and Bias point – DC analysis of transistor circuits - Various biasing methods of BJT – Bias circuit design - Thermal stability - Stability factor - Bias compensation techniques using Diode, Thermistor and Sensistor.					
UNIT II	BIASING OF JFET AND MOSFET	9			
JFET - DC load line and Bias point - Various biasing methods of JFET - JFET bias circuit design - MOSFET biasing - Biasing FET switching circuits.					
UNIT III	SINGLE STAGE BJT, JFET AND MOSFET AMPLIFIERS	9			
Small signal Hybrid π equivalent circuit of BJT – Early effect - Analysis of CE, CC and CB amplifiers using Hybrid π equivalent circuits - AC load line analysis, Small signal Hybrid π equivalent circuit of FET and MOSFET - Analysis of CS, CD and CG amplifiers using Hybrid π equivalent circuits.					
UNIT IV	MULTISTAGE BJT, FET AND MOSFET AMPLIFIERS	9			

Multistage BJT amplifiers - Darlington - Bootstrap – Cascade and Cascode configurations - Differential amplifier - Basic BJT differential pair – Small signal analysis and CMRR, Multistage JFET - Basic FET differential pair- BiCMOS circuits, Multistage MOSFET – Cascode amplifier.		
UNIT V	FREQUENCY RESPONSE OF AMPLIFIERS	9
Amplifier frequency response – Frequency response of transistor amplifiers with circuit capacitors – BJT frequency response – short circuit current gain - cut off frequency – f_{α} , f_{β} and unity gain bandwidth – Miller effect - Frequency response of FET - High frequency analysis of CE and MOSFET CS amplifier - Transistor switching times.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Analyze the biasing techniques of BJT using stability factor. CO2: Interpret the working principle of various biasing techniques of JFET and MOSFET. CO3: Design CE, CB and CC single stage amplifiers based on hybrid- π equivalent model. CO4: Inspect the effect of cascading BJT amplifiers on bandwidth. CO5: Analyze the low frequency and high frequency response of BJT, JFET and MOSFET.		
TEXT BOOKS: 1. Donald .A. Neamen, “Electronic Circuit Analysis and Design”, 2nd Edition, Tata Mc Graw Hill, 2009. 2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 11th Edition, Pearson Education, 2013. 3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” 2nd Edition, Tata Mc Graw Hill, 2007.		
REFERENCES: 1. S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, “Electronic Devices and Circuits”, 2nd Edition, TMH, 2017. 2. Adel .S. Sedra, Kenneth C. Smith, “Micro Electronic Circuits”, 6th Edition, Oxford University Press, 2010. 3. David A. Bell, “Electronic Devices and Circuits”, 5th Editon, Oxford Higher Education Press, 2010. 4. Millman and Halkias. C., “Integrated Electronics”, 2nd Edition, TMH, 2007.		

21EC203	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To infer the basic properties of signals and systems. • To gain knowledge about the continuous time signals and systems in the Fourier and Laplace domain. • To interpret the discrete time signals and systems in the Fourier and Z transform domain. • To be familiar with the analysis of differential equation of continuous time systems. • To introduce different methods of analysis of discrete time systems.					
UNIT I	CLASSIFICATION OF SIGNALS AND SYSTEMS	9			
Standard signals- Step, Ramp, Pulse, Impulse, Real and Complex exponentials and Sinusoids_ Classification of signals – Continuous Time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.					
UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS	9			
Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and properties.					
UNIT III	ANALYSIS OF DISCRETE TIME SIGNALS	9			
Baseband signal sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT - Z Transform and Properties.					
UNIT IV	LINEAR TIME INVARIANT - CONTINUOUS TIME SYSTEMS	9			
Convolution integrals - Differential Equation- Interconnection of LTI systems, Analysis of CT systems using Fourier and Laplace transforms- Stability and Causality.					
UNIT V	LINEAR TIME INVARIANT - DISCRETE TIME SYSTEMS	9			
Linear and Circular Convolutions- Sectioned Convolution- Difference Equations- Interconnection of LTI systems – Analysis of DT Systems using Discrete Time Fourier and Z Transform - Stability and Causality.					

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

- CO1: Interpret the classification of signals and systems.
- CO2: Apply Fourier and Laplace transform for continuous time signals.
- CO3: Apply Z transform and DTFT for discrete time signals.
- CO4: Make use of Laplace transform, Fourier transform to analyze the continuous time systems.
- CO5: Utilize Fourier and Z transform in discrete time system analysis.

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", 2nd Edition, Pearson, 2013.
2. S.Haykin and B.VanVeen "Signals and Systems, 2nd Edition, Wiley, 2007.
3. Hsu.H.P and Rakesh Ranjan, "Signals and Systems", Schaums's Outlines, 2nd Edition, Tata Mc Graw Hill, 2008.

REFERENCES:

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2nd Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.
4. Samir S. Soliman and Mandyam Dhati Srinath, "Continuous and Discrete Signals and Systems", 2nd Edition, Prentice-Hall International, 1998.

21CS214	OBJECT ORIENTED PROGRAMMING AND DATA STRUCTURES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To describe the fundamentals of object oriented programming in C++. • To explain the basics of OOP and Object-oriented approach to design software. • To illustrate the concept of data structures through ADT including List, Stack, Queues.					

- To demonstrate the concept of Non-Linear Data Structures and their applications. - To choose the various sorting and searching techniques.		
UNIT I	BASIC OOPS CONCEPTS	9
Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static ClassMembers – Overloading: Function overloading and Operator Overloading.		
UNIT II	INHERITANCE & POLYMORPHISM	9
Base Classes and Derived Classes – Protected Members – Overriding – Public, Protected and Private Inheritance – Constructors and Destructors in derived Classes - Class Object To Base – Class Object Conversion – Composition Vs. Inheritance – Virtual functions – This Pointer – Virtual Destructors – Dynamic Binding.		
UNIT III	LINEAR DATA STRUCTURES	9
Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists –Polynomial Manipulation - Stack ADT – Queue ADT - Evaluating arithmetic expressions		
UNIT IV	NON-LINEAR DATA STRUCTURES	9
Trees – Binary Trees – Binary tree representation and traversals – Application of trees: Set representation and Union-Find operations – Graph and its representations – Graph Traversals – Representation of Graphs – Breadth-first search – Depth-first search - Connected components		
UNIT V	SORTING AND SEARCHING	9
Sorting algorithms: Insertion sort - Quick sort - Merge sort - Searching: Linear search –Binary Search		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: CO1: Develop simple applications using Basic OOPS concepts. CO2: Build C++ programs using inheritance. CO3: Construct the concept of stack, linked list and memory allocation. CO4: Solve problems related to trees and Graphs. CO5: Compare different sorting and searching algorithms.		

TEXT BOOKS:

1. Herbert Schildt, "C++: The Complete Reference", 4th Edition, McGraw Hill Education, 2017.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 4th Edition, Addison-Wesley, 2014.
3. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, "Fundamentals of Data Structures in C++", Second edition, Universities Press, 2008.

REFERENCES:

1. Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press, 2010.
2. Goodrich, Michael T., Roberto Tamassia, David Mount, "Data Structures and Algorithms in C++", 2nd Edition, Wiley. 2013.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, McGraw Hill, 2010.

21EC204	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	2	4
COURSE OBJECTIVES : • To infer the basic building blocks of linear integrated circuits. • To illustrate the linear and non-linear applications of operational amplifiers. • To outline the concepts & applications of analog multipliers and PLL. • To explain the working principle of ADC and DAC. • To summarize the operation of waveform generation and some special function ICs.					
UNIT I	BASICS OF OPERATIONAL AMPLIFIERS				9
Basics of IC fabrication, Current mirror and current sources, Voltage sources, Voltage references, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal operational amplifier - General operational amplifier stages, Slew rate, Open and closed loop configurations, Basics of JFET operational amplifiers – LF155 and TL082.					
UNIT II	APPLICATIONS OF OPERATIONAL AMPLIFIERS				9
Sign changer, Scale changer, Voltage follower, V-to-I and I-to-V converters, Adder, Subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic					

amplifier, Comparator, Schmitt trigger, Precision rectifier, Peak detector, Clipper and Clamper, Op-amps in home applications.		
UNIT III	ANALOG MULTIPLIER AND PLL	9
Analog multiplier using Emitter coupled transistor pair - Gilbert multiplier cell –Analog multiplier ICs and their applications, Operation of basic PLL, Voltage controlled oscillator, Monolithic PLL IC 565, Application of PLL for AM detection, FM detection, FSK modulation and demodulation, Frequency synthesizing and Clock synchronization.		
UNIT IV	ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS	9
Analog and Digital data conversions, D/A converter – Weighted resistor type, R-2R Ladder type, Voltage mode and Current Mode R-2R Ladder types - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – Flash type - Successive approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion – A/D & D/A specifications.		
UNIT V	WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs	9
Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low drop-out (LDO) regulators - Isolation amplifier, Opto-couplers and Fibre optic IC.		
TOTAL: 45 PERIODS		
LIST OF EXPERIMENTS		
• Design & Testing of inverting, non inverting and differential amplifiers. • Design & Testing of integrator and differentiator, schmitt trigger using op-amp. • Design & Testing of PLL characteristics & its use as frequency multiplier and clock synchronization. • Design & Testing of R-2R Ladder Type D- A Converter using Op-amp. • Simulation using PSPICE- Astable and Monostable multivibrators using NE555 timer.		
TOTAL: 30 PERIODS		
COURSE OUTCOMES:		
At the end of the course, learners will be able to		

CO1: Outline the basic concepts of operational amplifiers.
 CO2: Construct op-amp circuits for linear and non-linear applications.
 CO3: Summarize about the analog multiplier and phase locked loop circuits.
 CO4: Build ADC and DAC circuits using op – amps.
 CO5: Explain the concepts of waveform generating circuits and special function ICs.

TEXT BOOKS:

1. D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, 6th Edition, New Age International Pvt. Ltd., 2021.
2. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, 3rd Edition, TMH, 2018.
3. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 3rd Edition, Tata Mc Graw-Hill, 2007.

REFERENCES:

1. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F.Coughlin & Frederick F.Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, 6th Edition, PHI, 2001.
3. B.S.Sonde, “System design using Integrated Circuits” , 2nd Edition, New Age Pub, 2001

21EC205	ANALOG AND DIGITAL CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES : • To obtain the frequency response of CE, CB, CC and CS amplifier. • To determine the bandwidth of multistage amplifiers and study the transfer characteristics of differential amplifier. • To perform SPICE simulation of BJT, JFET and MOSFET amplifiers using various biasing techniques. • To design various combinational digital circuits using logic gates. • To design synchronous and asynchronous sequential circuits.					
LIST OF ANALOG EXPERIMENTS:					

1. Frequency Response of CE and CB amplifiers
2. Frequency Response CC and CS amplifiers
3. Differential Amplifiers - Transfer characteristics, CMRR Measurement
4. Cascode and Cascade BJT amplifiers
5. Determination of bandwidth of single stage & multistage BJT amplifier
6. Analysis of BJT with Fixed bias and Voltage divider bias using PSPICE
7. Analysis of Cascode and Cascade BJT amplifiers using PSPICE

LIST OF DIGITAL EXPERIMENTS:

8. Study of logic gates and design of half adder and full adder
9. Design and implementation of code converters using logic gates
10. Design and implementation of 4 bit binary adder/ subtractor using IC 7483
11. Design and implementation of BCD adder using IC 7483
12. Design and implementation of multiplexer and de-multiplexer using logic gates
13. Design and implementation of encoder and decoder using logic gates
14. Construction and verification of 4 bit ripple counter and Mod-10/Mod-12 ripple counters
15. Design and implementation of 3-bit synchronous up/down counter
16. Design of Shift Registers using D flip-flops

TOTAL PERIODS : 60

COURSE OUTCOMES:

At the end of the course, learners will be able to

- CO1: Build CE, CB, CC, CS, Cascode / Cascade Amplifiers and obtain the frequency response.
- CO2: Analyze the transfer characteristics of Differential amplifier, Power amplifiers, bandwidth of single stage and Multistage amplifiers.
- CO3: Construct BJT, JFET and MOSFET amplifiers with various biasing techniques using SPICE.
- CO4: Develop multiplexer, de-multiplexer, encoder and decoder using logic gates.
- CO5: Experiment with synchronous and asynchronous sequential circuits.

21CS215	OBJECT ORIENTED PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES : • To describe the fundamentals of object oriented programming, particularly in C++. • To use object oriented programming to implement data structures. • To illustrate linear data structures and their applications. • To demonstrate non-linear data structures and their applications. • To explain the concept of data structures through ADT.					
LIST OF EXPERIMENTS					
1. Basic Programs for C++ Concepts 2. Array implementation of List Abstract Data Type (ADT) 3. Linked list implementation of List ADT 4. Cursor implementation of List ADT 5. Stack ADT - Array and linked list implementations 6. Implement stack Applications using Stack ADT 7. Queue ADT – Array and linked list implementations 8. Implement Queue Applications using Queue ADT 9. Search Tree ADT - Binary Search Tree 10. Graphs- Breadth first and Depth first search 11. Insertion sort 12. Quick Sort 13. Develop a C++ application to solve real world problem using ADT algorithms					
TOTAL: 60 PERIODS					
COURSE OUTCOMES: CO1: Develop simple applications using Basic OOPS concepts. CO2: Execute and Implement programs using inheritance and use them in programs. CO3: Construct the concept of stack, linked list and memory allocation.					

CO4: Solve problems related to trees and Graphs.

CO5: Compare different sorting and searching algorithms.

TEXT BOOKS:

1. Herbert Schildt, “C++: The Complete Reference”, 4th Edition, McGraw Hill Education, 2017.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, 4th Edition, Addison-Wesley, 2014.
3. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, “Fundamentals of Data Structures in C++”, 2nd Edition, Universities Press, 2008.

REFERENCES:

1. Bhushan Trivedi, “Programming with ANSI C++, A Step-By-Step approach”, Oxford University Press, 2010.
2. Goodrich, Michael T., Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, 2nd Edition, Wiley. 2011.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, McGraw Hill, 2010.
4. Bjarne Stroustrup, “The C++ Programming Language”, 4th Edition, Addison-Wesley, 2013.

SEMESTER IV

21MA206	PROBABILITY AND RANDOM PROCESSES	L	T	P	C
		3	2	0	4
COURSE OBJECTIVES: • To explain the basic concepts in probability and random variables. • To discuss the basics of random variables with emphasis on the standard discrete and continuous distributions. • To make use of the basic concepts of two dimensional random variables. • To use the basic concepts of random processes in engineering disciplines. • To explain the concept of correlation and spectral densities.					
UNIT I	PROBABILITY AND RANDOM VARIABLES				12

Axioms of probability, Conditional probability, Total probability, Bayes theorem, Random variables- Probability mass function- Probability density function-Properties-Moments- Moment generating functions and their properties.		
UNIT II	STANDARD DISTRIBUTIONS	12
Binomial -Poisson -Geometric – Uniform-Exponential –Gamma and Normal distributions and their properties- Functions of a random variable.		
UNIT III	TWO DIMENSIONAL RANDOM VARIABLES	12
Joint Distributions-Marginal And Conditional Distributions-Covariance-Correlation And Linear Regression- Transformations Of Random Variables-Central limit theorem(without proof)		
UNIT IV	CLASSIFICATION OF RANDOM PROCESSES	12
Definition and examples-first order-second order-strictly stationary-wide sense stationary and Ergodic processes-Markov process-Poisson and Normal processes-Sine wave process.		
UNIT V	CORRELATION AND SPECTRAL DENSITIES	12
Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties-Wiener – Khintchine relation- Relationship between cross power spectrum and cross correlation function- Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.		
		TOTAL: 60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Identify the basic concepts of Probability and Random variables. CO2: Experiment the performance of random variables in terms of distributions. CO3: Calculate the correlation and regression of two dimensional random variables. CO4: Make use of random processes concept in engineering disciplines. CO5: Apply the concept of correlation and spectral densities and the significance of linear systems with random inputs .		
TEXT BOOKS: 1. JAY.L. Devore, “Probability and Statistics for Engineering and the Science”, 8 th Edition,Cengage Learning India Pvt. Ltd, 2012.		

2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", 4th Edition, Tata McGraw Hill, 2002.
3. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", 3rd Indian Edition, Oxford University Press, New Delhi, 2012.

REFERENCES:

1. Miller. S.L. and Childers. D.G., —Probability and Random Processes with Applications to Signal Processing and Communications ", 2nd Edition, Academic Press, 2004.
2. Sheldon M.Ross, "Introduction to Probability Models". 11th edition, Academic Press, 2014
3. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.

21CH103	ENVIRONMENTAL SCIENCE	L	T	P	C
		2	0	0	2
COURSE OBJECTIVES: • To describe the structure and function of an ecosystem and biodiversity. • To interpret the environmental impacts of natural resources. • To demonstrate causes, effects and control measures of different types of pollution. • To manipulate the importance of disaster management, environmental ethics and values. • To dramatize the important social issues and sustainable practices.					
UNIT-I	ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY				6
Multidisciplinary nature of environmental studies - ecosystem- general structure and function of an ecosystem- ecological succession-biodiversity-types-values of biodiversity- endangered and endemic species-red data book- hot spots of biodiversity-criteria- hot spots in India-threats to biodiversity(man-animal conflicts, habitat loss, poaching)-case studies-conservation of biodiversity- in-situ and ex-situ conservation.					
UNIT-II	NATURAL RESOURCES AND ITS ENVIRONMENTAL IMPACTS				6
Natural resources-forest resource-ecological functions – causes, effects and control measures of deforestation-water resource-sources-conflict over water-dams benefits and problems-food resource-overgrazing- impacts of over grazing- impacts of modern agriculture-energy resource-environmental impacts of wind mills and solar panels- role of an individual in conservation of natural resources.					

UNIT III	ENVIRONMENTAL POLLUTION AND CONTROL	6
Air pollution-causes, effects and control methods - water pollution- causes, effects-waste water treatment-soil pollution-causes, effects-solid waste management–e-waste- causes, effects and management-Pollution control acts-air(prevention and control of pollution) act,1981-water(prevention and control of pollution) act,1974- wildlife (protection) act,1972 - e-waste management rules,2016-case studies - role of an individual in control of pollution.		
UNIT IV	DISASTER MANAGEMENT AND ENVIRONMENTAL ETHICS	6
Disaster management-causes, effects and management of- flood, landslide, earthquake and tsunami-case studies- environmental ethics- value education-traditional value systems in India-water conservation-rain water harvesting-watershed management.		
UNIT V	SOCIAL ISSUES AND SUSTAINABLE PRACTICES	6
Unsustainable development- social issues-climate change-causes, effects and control measures-global warming-causes, effects and control measures-Acid rain-causes, effects and control measures-ozone layer depletion-causes, effects and control measures-nuclear accident and holocausts-EIA-Sustainable development-goals-target- green buildings- ISO 14000 series.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to - CO 1 : Explain the concept, structure and function of an ecosystem and biodiversity. - CO2 : Demonstrate the environmental impacts of natural resources. - CO 3 : Illustrate the suitable management method for pollution control. - CO 4 : Relate the proper way of managing disaster with environmental ethics. - CO5 : Apply social issues and adopt suitable sustainable practices.		
TEXT BOOKS: 1. Kaushik, A & Kaushik. C.P, “Environmental Science and Engineering”, 6th Edition, New Age International, 2018. 2. Garg S.K &Garg, Ecological and Environmental studies, Khanna Publishers, 2015. 3. Wright &Nebel, Environmental science towards a sustainable future, 12th Editon, Prentice Hall of India Ltd, 2015.		
REFERENCES: 1. ErachBharucha, “Text book of Environmental studies for Undergraduate courses”, 3rd		

Edition, UGC, 2021.
2. Ravi P. Agrahari, Environmental ecology, Biodiversity, climatic change & Disaster management, 1 st Edition, McGraw Hill, 2020.
3. Benney Joseph, “Environmental Science and Engineering”, 1 st Edition, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2017.

21EC206	ELECTRONIC CIRCUITS II	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : - To infer the principles of feedback amplifiers. - To explain the operation of RC & LC oscillators. - To demonstrate the concept of tuned amplifiers. - To explain various wave shaping and multivibrator circuits. - To demonstrate the working principle of power amplifiers and DC convertors.					
UNIT I	FEEDBACK AMPLIFIERS	9			
Feedback concept – Block diagram – Loop gain – Transfer gain with feedback – General characteristics of negative feedback amplifiers – Input resistance – Output resistance – Method of identifying feedback topology – Analysis of voltage-series, current-series, current-shunt and voltage shunt feedback amplifiers.					
UNIT II	OSCILLATORS	9			
Oscillators – Barkhausen criterion – Mechanism for start of oscillation and stabilization of amplitude, Analysis of RC oscillators – Phase shift – Wien bridge, Analysis of LC oscillators – Hartley ,Colpitt’s & Clapp oscillators, Crystal oscillators –Miller and Pierce Crystal oscillators.					
UNIT III	TUNED AMPLIFIERS	9			
Small signal tuned amplifiers – Analysis of capacitor coupled single tuned amplifier – Double tuned amplifier – Effect of cascading single tuned and double tuned amplifiers on bandwidth – Neutralization - Hazeltine neutralization method.					
UNIT IV	WAVE SHAPING AND MULTIVIBRATOR CIRCUITS	9			
RC integrator and differentiator circuits, Diode clippers and clampers, Multivibrators –					

Triggering methods, Collector coupled Astable multivibrator, Monostable multivibrator, Bistable multivibrator - Fixed bias and Self Bias, Schmitt Trigger.		
UNIT V	POWER AMPLIFIERS AND DC CONVERTERS	9
Power amplifiers- Class A- Class B- Class AB- Class C, Power MOSFET-Temperature effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Analysis of Buck, Boost and Buck-Boost amplifiers.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Identify the topologies of feedback amplifiers. CO2: Compare the various types of RC and LC oscillators. CO3: Experiment with different types of tuned amplifiers. CO4: Illustrate wave shaping and multi vibrator circuits. CO5: Describe the concept of Power amplifiers and DC converters.		
TEXT BOOKS: 1. Millman and Halkias. C., “Integrated Electronics”, TMH, 2007. 2. Millman J. and Taub H., “Pulse Digital and Switching Waveforms”, TMH, 2000. 3. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, 3 rd Edition, TMH, 2012.		
REFERENCES: 1. Sedra and Smith, “Micro Electronic Circuits”, 6 th Edition, Oxford University Press, 2011. 2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10 th Edition, Pearson Education / PHI, 2008.. 3. David A. Bell, “Electronic Devices and Circuits”, 5 th Edition, Oxford University Press, 2008. 4. Jacob Millman, ‘Microelectronics’, 2 nd Edition, McGraw Hill, Reprinted, 2009.		

21EC207	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To infer the rudiments of electromagnetic theory in free space and in materials. • To explain the electro static fields and parameters through Coloumb’s law and Gauss’s law. • To familiarize with magneto static theorems & laws and infer the behavior of Magnetic materials. • To derive the Maxwell’s equations. • To summarize the wave propagation mechanism in lossless and in lossy media.					
UNIT I	INTRODUCTION	9			
Electromagnetic model, Units and Constants, Nature of Scalars and Vectors, Review of vector algebra, Rectangular, Cylindrical and Spherical coordinate systems, Line, Surface and Volume integrals, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem, Null identities, Helmholtz's theorem.					
UNIT II	ELECTROSTATICS	9			
Introduction to Electro static fields, Coulomb's law, Electric field intensity, Field due to continuous charge distribution- Field due to line charge- Field due to a sheet of charge - Gauss's law and applications, Electric potential, Electric flux density and Dielectric constant, Boundary conditions, Capacitance, Parallel, Cylindrical and Spherical capacitors, Electrostatic energy, Poisson's and Laplace's equations, Uniqueness of electrostatic solutions, Current density and Ohm's law, Continuity equation, Energy stored in electric fields and Energy density.					
UNIT III	MAGNETOSTATICS	9			
Lorentz force equation, Law of non magnetic monopoles, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity, Ampere’s circuital law and applications, Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and Inductors, Magnetic energy, Magnetic forces and torques.					
UNIT IV	TIME-VARYING FIELDS AND MAXWELL’S EQUATIONS	9			
Time Varying Fields, EMF and MMF, Faraday’s law, Displacement current and current density, Modified form of Ampere’s circuital law, Maxwell’s equations in integral form and differential form – Poynting vector and power flow, Power flow in a co–axial cable – Instantaneous, Average and Complex poynting vector and Electromagnetic boundary conditions.					

UNIT V	PLANE ELECTROMAGNETIC WAVES	9
Wave equations and solutions - Plane waves in lossless media, Plane waves in lossy media (Low-loss dielectrics and good conductors), Waves in ionized medium, Group velocity, Skin depth, Polarization – Linear, Circular and Elliptical polarization; Reflection by a perfect conductor -Normal and Oblique incidence - Reflection by a dielectric- Normal and Oblique incidence.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to: CO1: Relate various coordinate systems and vector algebra. CO2: Apply the basic laws to evaluate electric fields and potentials due to static charges. CO3: Solve magnetic fields with the help of Biot Savart’s law and Ampere circuital law. CO4: Outline the principles of time varying fields and Maxwell’s equations. CO5: Explain the plane electromagnetic waves in lossless and lossy media.		
TEXT BOOKS: 1. D.K. Cheng, “Field and Wave Electromagnetics”, 2nd Edition, Pearson (India), 2014 2. W.H. Hayt and J.A. Buck, “Engineering Electromagnetics”, 8th Edition, McGraw-Hill (India), 2012. 3. Joseph A. Edminister and Mahmood Nahvi, Schaum’s Outline of Electromagnetics, 5th Edition, McGraw Hill, 2019.		
REFERENCES: 1. John D Kraus and Daniel Fleisch, “Electromagnetics”, 5th Edition, McGraw Hill, 2017. 2. D.J. Griffiths, “Introduction to Electrodynamics”, 4th Edition, Pearson (India), 2013. 3. B.M. Notaros, “Electromagnetics”, 1st Edition, Pearson: New Jersey, 2011. 4. M.N.O. Sadiku and S.V. Kulkarni, “Principles of Electromagnetics”, 6th Edition, Oxford (Asian Edition), 2015.		

21EC208	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : - To gain knowledge about the architecture of 8086 Microprocessor and assembly language programming fundamentals. - To develop skills in interfacing of peripheral devices with 8086 Microprocessor, 8051 Microcontroller and MSP430 Microcontroller. - To explain about 8086 Microprocessor and 8051 Microcontrollers. - To demonstrate the architecture of MSP430 Microcontroller. - To develop microcontroller based systems.					
UNIT I	ARCHITECTURE OF 8086 AND ASSEMBLY LANGUAGE PROGRAMMING	12			
Microprocessor families – 8086 – Architecture – Instruction set – Addressing modes – Bus cycles – Assembly language programming of 8086 – Assembler directives – Interrupts and applications.					
UNIT II	PERIPHERAL INTERFACING	12			
External memory interface – Programmable peripheral interface (8255) – Serial communication interface (8251) – Keyboard and Display interface (8279) – Programmable timer controller (8253/8254) – Programmable interrupt controller (8259).					
UNIT III	8051 MICROCONTROLLER	12			
8051 Microcontroller – Instruction set – Assembly Language Programming – I/ O interfacing – 8051 Timers –USART – Interrupts – 8051 programming in C					
UNIT IV	MSP430 MICROCONTROLLER	12			
Architecture introduction - Embedded C Programming in MSP430 - GPIO pins & configuration - Timers, Capture & PWM – DAC – ADC Ports - I2C					
UNIT V	SYSTEM DESIGN USING MICROCONTROLLERS	12			
ADC & DAC interfacing – Sensor interfacing – RTC interfacing (DS1307) using I2C Standard – Relay, Motor control – DC & Stepper motor – System design: Traffic Light Controller & Digital weighing machine					

TOTAL: 60 PERIODS	
COURSE OUTCOMES: At the end of this course, learners will be able to: CO1: Explain the architecture of Microprocessors and Microcontrollers. CO2: Analyze various types of Interfacing techniques. CO3: Write assembly language program for 8086 Microprocessor, 8051 and MSP430 Microcontrollers. CO4: Demonstrate the architecture of MSP430 Microcontroller. CO5: Develop ALP for microcontroller based system design.	
TEXT BOOKS: 1. Douglas V Hall, “Microprocessors and Interfacing”, 3 rd Edition, McGraw Hill Education, 2012. 2. Muhammad Ali Mazidi, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, 2 nd Edition, Pearson India, 2007. 3. John H. Davies, "MSP430 Microcontroller Basics", 2 nd Edition, Newnes, 2008.	
REFERENCES: 1. A.K. Ray and K.M. Burchandi, “Intel Microprocessors Architecture Programming and Interfacing”, McGraw Hill, 2000. 2. Sunil Mathur, "Microprocessor 8086: Architecture, Programming and Interfacing", PHI Learning Pvt.Ltd., 2011. 3. Kenneth Ayala, "The 8051 Microcontroller”, 3 rd Edition, Delmar Cengage Learning, 2004.	

21EC209	ANALOG COMMUNICATION	L	T	P	C
		3	0	2	4
COURSE OBJECTIVES : - To explain the concept of various Amplitude modulation techniques. - To gain knowledge about the Angle Modulation Techniques. - To analyze the performance of Continuous Wave Modulation Systems. - To be familiarize with various noises.					

To demonstrate the Information Theory and Source Coding.		
UNIT I	AMPLITUDE MODULATION	10
Communication systems – Classification of modulation techniques-Amplitude Modulation-Mathematical representation-Modulation index, Spectra, Power relations, Transmission bandwidth and efficiency –Generation & Detection – AM,DSBSC,SSBSC,VSB - Pre-envelope & complex envelope –comparison of different AM techniques, Super heterodyne Receiver.		
UNIT II	ANGLE MODULATION	9
Phase and frequency modulation, Narrow band and wide band FM – Modulation index, Spectra, Power relations and transmission bandwidth - FM modulation –Direct and Indirect methods, FM Demodulation – FM to AM conversion, FM Discriminator - PLL as FM demodulator.		
UNIT III	NOISE THEORY	9
Types of Noise – Shot noise, Thermal noise and white noise; Noise calculations - Noise Figure-Noise temperature -Noise Equivalent Bandwidth- Narrow band noise ,Representation of Narrow band noise –In-phase & quadrature and envelope and phase components.		
UNIT IV	PERFORMANCE OF AM AND FM MODULATION SYSTEMS	8
Noise in AM receivers- Noise in DSB-SC receiver- Noise in SSB receiver- Noise in FM receivers- Capture and threshold effect- Pre-emphasis and de-emphasis in FM-Comparison of noise performance of AM and FM systems.		
UNIT V	PULSE ANALOG MODULATION	9
Low pass sampling - Aliasing- Signal reconstruction - Quantization - Uniform and non uniform quantization, quantization noise, Logarithmic Companding ; PAM, PPM, PWM, PCM, Multiplexing-TDM,FDM.		
TOTAL : 45 PERIODS		
LIST OF EXPERIMENTS:		
- Amplitude Modulation and Demodulation - Frequency Modulation and Demodulation - Study the performance of AM and FM for noisy (random, thermal, and impulse) signal by measuring SNR of demodulated signal - Design and Testing of Pre-Emphasis / De-emphasis Circuits. - Pulse Code Modulation		

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

- CO1: Design, Test and Compare various amplitude modulators and demodulators with practical design parameters.
- CO2: Design, Test and Compare various angle modulators and demodulators with practical design parameters.
- CO3: Analyze the various noises in Analog systems.
- CO4: Compare the performance of AM and FM modulation systems.
- CO5: Outline the concepts of pulse analog modulation schemes with experimental design parameters.

TEXT BOOKS:

1. Simon Haykin, “Communication Systems”, 4th Edition, Wiley, 2014.
2. J.G.Proakis, M.Salehi, “Fundamentals of Communication Systems”, Pearson Education 2014.
3. R.P Singh and S.D.Sapre, “Communication Systems – Analog and Digital”, Tata McGraw Hill, 2nd Edition, 2007.

REFERENCES:

1. A. Bruce Carlson & Paul B Crilly, “Communication Systems”, McGraw Hill, 4th Edition, 2009.
2. Dennis Roddy & John Coolen –“Electronic Communication” Prentice Hall of India, 4th Edition, 1995.
3. Lathi B. P. And Ding Zhi, “Modern Digital and Analog Communication Systems”, Oxford Press, 4th Edition, 2011.

21EC210	CIRCUIT DESIGN AND SIMULATION LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES : • To design feedback Amplifier circuits and to measure gain, Input and output resistances and compare their performance with and without feedback. • To design Oscillators and verify its outputs.					

- To gain hands-on experience on wave shaping and tuned amplifier circuits.
- To acquire knowledge to construct Astable and Monostable Multivibrator circuits.
- To model electronic circuits using circuit simulation tool.

LIST OF EXPERIMENTS:

DESIGN AND ANALYSIS OF THE FOLLOWING CIRCUITS

1. Voltage Series and Current Shunt feedback amplifiers
2. Hartley Oscillator and Colpitts Oscillator
3. Clippers and Clampers circuits
4. Astable and Monostable multivibrators
5. Class C amplifier

SIMULATION USING PSPICE:

6. Single tuned and double tuned amplifiers
7. Phase shift oscillator
8. Wein Bridge Oscillator
9. Multivibrators

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to

- CO1: Analyze the various types of negative feedback amplifiers
- CO2: Construct RC and LC oscillators
- CO3: Experiment with Single tuned amplifiers and Wave Shaping circuits
- CO4: Build Astable and Monostable multivibrator circuits
- CO5: Make use of PSPICE tool to simulate Oscillators, Multivibrator Circuits and Power Amplifiers

21EC211	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES : • To study ALP concepts, features and Coding methods. • To learn ALP for arithmetic and logical operations in 8086 and 8051. • To differentiate Serial and Parallel Interface. • To interface different I/Os with Microprocessors. • To be familiar with MASM.					

LIST OF EXPERIMENTS:	
8086 PROGRAMS USING KITS AND MASM 1. Basic arithmetic and Logical operations 2. Move a data block without overlap 3. Code conversion, decimal arithmetic and Matrix operations. 4. Floating point operations, string manipulations, sorting and searching 5. Password checking, Print RAM size and system date 6. Counters and Time Delay	
PERIPHERALS AND INTERFACING EXPERIMENTS 7. Traffic light control 8. Stepper motor control 9. Digital clock 10. Key board and Display 11. Printer status 12. Serial interface and Parallel interface 13. A/D and D/A interface and Waveform Generation	
8051 EXPERIMENTS USING KITS AND MASM 14. Basic arithmetic and Logical operations 15. Square and Cube program, Find 2's complement of a number 16. Unpacked BCD to ASCII 17. UART operations in 8051 using C. 18. MSP430 GPIO Programming 19. MSP430 DAC & PWM Programming 20. MSP430 Low Power Mode Programming 21. Mini Project.	
TOTAL : 60 PERIODS	
COURSE OUTCOMES: At the end of the course, the student will be able to CO1: Write ALP Programmes for fixed and Floating Point and Arithmetic operations. CO2: Interface different I/Os with processor. CO3: Generate waveforms using Microprocessors. CO4: Execute Programs in 8051. CO5: Explain the difference between simulator and Emulator.	

SEMESTER V

21EC301	DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the parameters of information theory. • To interpret the various waveform coding and line coding techniques. • To summarize the baseband transmission and reception schemes. • To illustrate various bandpass signaling schemes. • To outline the fundamentals of channel coding.					
UNIT I	INFORMATION THEORY	9			
Discrete memoryless source, Information, Entropy, Mutual Information - Discrete Memoryless Channels, Binary Symmetric Channel, Channel Capacity - Hartley - Shannon law - Source coding theorem - Shannon & Huffman codes.					
UNIT II	WAVEFORM CODING AND REPRESENTATION	9			
Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles - Linear Predictive Coding- Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ, Bipolar NRZ – Manchester					
UNIT III	BASEBAND TRANSMISSION AND RECEPTION	9			
ISI, Nyquist criterion for distortion less transmission, Pulse shaping, Correlative coding - Eye pattern, Receiving Filters- Matched Filter, Correlation receiver, Adaptive Equalization					
UNIT IV	DIGITAL MODULATION SCHEME	9			
Geometric Representation of signals - Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers - Principle of DPSK.					
UNIT V	ERROR CONTROL CODING	9			
Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder, ARQ & FEC.					

TOTAL : 45 PERIODS	
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Outline the parameters of information theory. CO2: Compare different waveform coding and line coding techniques. CO3: Illustrate the different baseband transmission and reception schemes. CO4: Explain bandpass signaling schemes and its spectral characteristics. CO5: Apply error control coding schemes for error correction.	
TEXT BOOKS: 1. Simon Haykin, “Digital Communication”, 1 st Edition, John Wiley, Reprint 2009. 2. B.Sklar, F. J. Harris, “Digital Communication Fundamentals and Applications”, 3 rd Edition, Pearson Education, 2020. 3. K. Sam Shanmugam, “Digital and Analog Communication Systems”, Wiley, 2019	
REFERENCES: 1. H P Hsu, “Schaum Outline Series -Analog and Digital Communications”, 3 rd Edition, TMH, 2017. 2. J.G Proakis, M. Salehi, “Digital Communication”, 5 th Edition, TMH, 2014. 3. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 4 th Edition, Oxford University Press, 2017.	

21EC302	TRANSMISSION LINES AND RF SYSTEMS	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: - To explore various types of transmission lines and its characteristics. - To know about high frequency lines, power and impedance measurements. - To apply the knowledge in impedance matching concepts using Smith Chart. - To summarize the wave propagation in waveguides. - To design RF transceivers.					

UNIT I	TRANSMISSION LINE THEORY	9
General theory of Transmission lines - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion-less line - Loading and different methods of loading - Line not terminated by Z_0 - Reflection coefficient - calculation of current, voltage, power delivered and efficiency of transmission - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss.		
UNIT II	HIGH FREQUENCY TRANSMISSION LINES	9
Transmission line equations at radio frequencies - Line of zero dissipation - Voltage and current on the dissipation-less line, Standing Waves, Nodes, Standing Wave Ratio - Input impedance of the dissipation-less line - Open and short circuited lines - Power and impedance measurement on lines - Reflection losses - Measurement of VSWR and wavelength.		
UNIT III	IMPEDANCE MATCHING IN HIGH FREQUENCY LINES	9
Impedance matching: Quarter wave transformer - Impedance matching by stubs –Single stub and double stub matching - Smith chart - Solutions of problems using Smith chart -Single and double stub matching using Smith chart.		
UNIT IV	WAVEGUIDES	9
General Wave behaviors along uniform guiding structures, Transverse Electromagnetic waves, Transverse Magnetic waves, Transverse Electric waves, TM and TE waves between parallel plates, TE and TM waves in Rectangular wave guides, Bessel function, TE and TM waves in Circular wave guides.		
UNIT V	RF SYSTEM DESIGN CONCEPTS	9
Active RF components: Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High electron mobility transistors, Basic concepts of RF circuit design, Mixers, Low noise amplifiers, voltage control oscillators, power amplifiers, transducer power gain and stability considerations.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the basic concepts of Transmission Line theory CO2: Outline the signal propagation in Transmission Lines at High frequencies. CO3: Develop impedance matching networks using Smith Chart.		

CO4: Choose guided systems for electromagnetic wave propagation. CO5: Design RF Transceivers.
TEXT BOOKS: 1. John D Ryder, “Networks, Lines and Fields”, 2nd Edition, Prentice Hall India, 2015. 2. Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics Illustrated”, 2nd Edition, Pearson Education Asia, 2015. 3. E.C.Jordan and K.G. Balmain, “Electromagnetic Waves and Radiating Systems”, 2nd Edition, Prentice Hall of India, 2015.
REFERENCES: 1. Reinhold Ludwig and Powel Bretchko, “RF Circuit Design – Theory and Applications”, 1st Edition, Pearson Education Asia, 2001. 2. D. K. Misra, “Radio Frequency and Microwave Communication Circuits- Analysis and Design”, 2nd Edition, John Wiley & Sons, 2004. 3. G.S.N Raju, "Electromagnetic Field Theory and Transmission Lines", 1st Edition, Pearson Education, 2006.

21EC303	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	2	4
COURSE OBJECTIVES: • To explain the concepts of DFT and FFT. • To design IIR filters and to filter undesirable signals in various frequency bands. • To compare the performance of various windowing techniques used to realize linear phase FIR filters. • To illustrate the effects of finite precision representation on digital filters. • To identify the concepts behind multivariate signal processing techniques.					
UNIT I	DISCRETE FOURIER TRANSFORM	9			
Review of signals and systems, Discrete Fourier transform (DFT), deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT),					

Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.		
UNIT II	INFINITE IMPULSE RESPONSE DIGITAL FILTERS	9
Review of design of analog Butterworth and Chebyshev Filters, Frequency Transformation in analog domain, Design of IIR digital filters using Impulse Invariance technique, Design of digital filters using bilinear transform, pre-warping, Realization of IIR digital filters: direct form I, direct form II, cascade and parallel forms.		
UNIT III	FINITE IMPULSE RESPONSE DIGITAL FILTERS	9
Symmetric and Anti-symmetric FIR filters, Linear phase FIR filters, Design of linear phase FIR filters using Rectangular, Hamming, Hanning and Blackmann Windows, Frequency sampling method, Realization of FIR filters, Transversal, Linear phase realization structures.		
UNIT IV	FINITE WORD LENGTH EFFECTS	9
Fixed point and floating point number representation, Truncation and Rounding errors, Quantization noise, Derivation for quantization noise power, Coefficient quantization error, Product quantization error, Overflow error, Round off noise power, limit cycle oscillations due to product round off and overflow errors, signal scaling.		
UNIT V	MULTIVARIATE SIGNAL PROCESSING	9
Multivariate Time Series: Time Domain Approach, Concept of Stochastic Processes, Stationarity and Ergodicity, Time series models: AR Models & ARMA Models, Estimating time series models from data, Assessing the relations among time series, Information theoretic measures: Mutual information and complexity.		
TOTAL : 45 PERIODS		
LIST OF EXPERIMENTS		
1. Generation of elementary Discrete-Time sequences. 2. Convolution and Correlation. 3. Frequency Analysis using DFT. 4. Sampling and Effect of Aliasing. 5. Design of FIR filters. 6. Design of IIR Filters.		
TOTAL : 30 PERIODS		
COURSE OUTCOMES:		

At the end of this course, learners will be able to

CO1: Apply the concepts of FFT for linear filtering.

CO2: Construct IIR filters using various transformation techniques.

CO3: Realize FIR Filters using Windowing and Frequency Sampling techniques.

CO4: Analyze the effects of finite word length in signal processing.

CO5: Outline multivariate signal processing techniques.

TEXT BOOKS:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing - Principles, Algorithms & Applications", 4th Edition, Pearson Education, 2007.
2. B. Venkatramani and M. Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2017.
3. V. Oppenheim, R. W. Schaffer and J. R. Buck, "Discrete-Time Signal Processing", 4th Edition, Pearson Education, 2011.

REFERENCES:

1. Iffachor E.C. and Jervis B.W., "Digital Signal Processing: A Practical Approach", 2nd Edition, Pearson Education, 2002.
2. Sanjit. K. Mitra "Digital Signal Processing - A computer based approach", 4th Edition, Tata McGraw Hill, 2011.
3. Andreas Antoniou, "Digital Signal Processing: Signals, Systems and Filters", Tata McGraw Hill, 2006.
4. Monson H Hayes, "Schaum's Outlines of - Digital Signal Processing", 2nd Edition, Tata McGraw Hill, 2012.

21EN301	PROFESSIONAL COMMUNICATION LABORATORY <i>(Common to all B.E./B.Tech. Programmes)</i>	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To demonstrate communication skills that can lead to improved interpersonal relationships.
- To plan to set and achieve goals with focus.
- To organize themselves in work life to face the professional set up with confidence.
- To interpret ideas and participate in group discussion with positive attitude.

To develop their confidence and help learners to attend interviews successfully.		
UNIT I	COMMUNICATION AND PROFESSIONAL ETIQUETTES	6
•Importance and Types of Communication Verbal communication -Presentation skills- Non-Verbal communication - Personal Appearance, Posture, Gestures, Facial Expressions, Eye Contact and Space Distancing - Professional Etiquette		
UNIT II	GOAL SETTING AND MOTIVATION	6
Short term and Long term Goals- Strategies to set and achieve goals- Motivation		
UNIT III	TIME AND STRESS MANAGEMENT	6
Importance of Time - Time Management Skills - Sources of Stress - Managing Stress - Analysis of the Case Studies on time and stress management		
UNIT IV	GROUP DISCUSSIONS AND POSITIVE ATTITUDE	6
Group Discussions - Leadership Qualities - Decision Making - Problem Solving - Negotiation Skills - Positive Attitude		
UNIT V	RESUME MAKING AND INTERVIEW SKILLS	6
Preparing Resume - E - Resume - Covering Letter – Job Application through email - Career Portfolio - Types of Interviews - Mock Interviews		
		TOTAL: 30 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to: CO1: Demonstrate effective communication skills through presentations. CO2: Utilize their knowledge of motivation in setting and achieving goals. CO3: Examine time and stress management. CO4: Formulate their ideas into an effective communication in formal contexts. CO5: Develop a well-composed resume and face interviews confidently.		
TEXT BOOKS: 1. Dhanavel S P, “English and Soft Skills”, 1 st Edition , Orient Black Swan Ltd, Hyderabad 2012. 2. Dr. Tobin Porterfield & Bob Graham ,“The 55 Soft Skills That Guide Employee and		

Organizational Success,” Mason – West Publishing House ,January 4-2018
3. Prashant Sharma, “Soft Skills Personality Development for Life Success, “BPB Publications, New Delhi, January 2018.
REFERENCES:
1. M. Ashraf Rizvi, “Effective Technical Communication,” Tata McGraw Hill Education Pvt. Ltd. New Delhi, 2016.
2. Mohan Krishna & Meera Banerji, “Developing Communication Skills,” 1 st Edition, Trinity Press, 2017.
3. N. Krishnaswami & T. Sriraman, “Creative English for Communication,” 3 rd Edition, Laxmi Publications Private Limited, 2017.

SEMESTER VI

21EC304	ANTENNAS AND WAVE PROPAGATION	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To illustrate the basic principles of antennas. • To explore the radiation mechanism of antennas. • To gain knowledge about the characteristics and design of antenna arrays. • To design Microstrip Patch Antennas. • To inspect different Propagation Phenomena related to Radiation.					
UNIT I	ELECTROMAGNETIC RADIATION AND ANTENNA FUNDAMENTALS				12
Vector potential – Solution to wave equation – Retarded vector and scalar potential – Hertzian dipole – Antenna characteristics – Radiation pattern, Beam solid angle, Directivity, Gain, Input impedance, Polarization, Beam width, Bandwidth, Reciprocity, Equivalence of Radiation patterns, Effective aperture, Effective length, Antenna temperature.					
UNIT II	WIRE ANTENNAS AND ANTENNA ARRAYS				12
Short dipole – Radiation resistance and Directivity – Half wave Dipole – Monopole – Small loop antennas – Antenna Arrays – Linear Array and Pattern Multiplication, Two–element Array, Uniform Array – Array with non– uniform Excitation – Binomial Array and Dolph					

Tchebychef Array.		
UNIT III	APERTURE ANTENNAS	12
Magnetic Current and its fields – Uniqueness theorem – Field equivalence principle – Duality principle – Method of Images – Pattern properties – Slot antenna – Horn Antenna – Pyramidal Horn Antenna – Reflector Antennas – Parabolic Reflectors-Flat Reflector – Corner Reflector-Lens Antenna.		
UNIT IV	SPECIAL ANTENNAS AND ANTENNA MEASUREMENTS	12
Yagi Uda Antenna – Helical Antenna – Axial mode helix, Normal mode helix- Biconical Antenna, Log Periodic Dipole Array – Spiral Antenna – Microstrip Patch Antennas – Metamaterial Antennas- Fractal Antennas, Reconfigurable Antennas, Optical Antennas, Antenna Measurements- Radiation Pattern, Gain and Directivity, Impedance. Anechoic Chamber.		
UNIT V	RADIO WAVE PROPAGATION	12
Free Space Propagation -FRIS Transmission Formula – Ground Wave Propagation, Ground Reflection, Surface Waves, Space Waves – Diffraction – Wave Propagation in Complex Environments – Tropospheric Propagation – Tropospheric Scatter – Ionospheric Propagation – Structure of Ionosphere, Sky Waves, Skip Distance, Virtual Height, Critical Frequency, MUF, Electrical Properties of Ionosphere – Effects of Earth's Magnetic Fields.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Summarize the fundamentals of antennas. CO2: Construct wire antennas and antenna arrays. CO3: Analyze the characteristics aperture antennas. CO4: Explain the characteristics of special antennas and procedure to measure antenna parameters. CO5: Analyze the Atmospheric Effects on Radio Wave Propagation.		
TEXT BOOKS: 1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation", 5 th Edition, Tata McGraw-Hill, 2017. 2. Constantine A.Balanis, "Antenna Theory Analysis and Design", 4 th Edition, John Wiley		

India Pvt Ltd., 2016. 3. R.E.Collin, "Antennas and Radiowave Propagation", 2nd Edition, Tata McGraw-Hill, 2007.
REFERENCES: 1. A.R.Harish, M.Sachidanada, “Antennas and Wave Propagation”, 2nd Edition, Oxford University Press, 2007. 2. K.D.Prasad, “Antenna Wave Propagation” 4th Edition, Sathya Prakashan Publication, 2019. 3. W.L Stutzman and G.A. Thiele, “Antenna Analysis and Design”, 3rd Edition, John Wiley, 2016.

21EC305	VLSI AND CHIP DESIGN	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the fundamentals of CMOS circuits and its characteristics. • To design combinational and sequential circuits using verilog HDL. • To analyze the combinational & sequential digital circuits. • To construct the arithmetic blocks and memory subsystems. • To illustrate the methods of testing CMOS circuits.					
UNIT I	INTRODUCTION TO MOS TRANSISTOR	9			
VLSI Design Flow, MOS Transistor, CMOS logic, Pass Transistor, Transmission gate, Layout Design Rules, Stick Diagrams, I-V Characteristics, C-V Characteristics, Non ideal I-V Effects, DC Transfer characteristics					
UNIT II	CIRCUIT DELAY AND VERILOG HDL	9			
Delay estimation – Logical effort and Transistor sizing – Power dissipation – Interconnect – Design Margin-Reliability – Scaling Basic concepts – identifiers – gate primitives – gate delays – operators – timing controls – procedural assignments –conditional statements – Design of combinational and sequential circuits using four types of modeling –Test benches					

UNIT III	COMBINATIONAL AND SEQUENTIAL CIRCUIT DESIGN	9
Combinational Circuits - Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Introduction to Low power VLSI Design, Sequential Circuits - Static latches and Registers, Dynamic latches and Registers.		
UNIT IV	DESIGN OF ARITHMETIC BUILDING BLOCKS AND MEMORY SUBSYSTEMS	9
Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, SRAM–Memory cell read/write operation, Decoders, Bit-line conditioning and Column circuitry– DRAM –Sub array architectures and Column circuitry.		
UNIT V	CMOS TESTING	9
Need for testing – Testers, Test fixtures and test programs – Logic verification – Silicon debug principles – Manufacturing test – Design for testability – Boundary scan test.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Outline the concepts of digital building blocks using MOS transistor. CO2: Make use of Verilog HDL to synthesize combinational and sequential circuits. CO3: Examine combinational MOS circuits and sequential circuits. CO4: Develop arithmetic building blocks and memory subsystems using CMOS. CO5: Summarize the methods of CMOS testing.		
TEXT BOOKS: 1. Neil H.E. Weste, David Money Harris, “CMOS VLSI Design: A Circuits and Systems Perspective”, 4th Edition, Pearson Education, 2011. 2. Jan M. Rabaey, Anantha P.Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits: A Design perspective”, 2nd Edition , Pearson Education, 2003. 3. J.Bhasker, “A Verilog HDL Primer”, 3rd Edition, Star Galaxy Publishing, 2018.		
REFERENCES: 1. Uyemura J.P, “Introduction to VLSI circuits and systems”, 1st Edition, Wiley 2009. 2. M.J. Smith, “Application Specific Integrated Circuits”, 1st Edition, Addison Wesley,		

2009.

3. D.A Pucknell and K.Eshraghian, “Basic VLSI Design”, 3rd Edition, PHI, 2007.
4. Wayne Wolf, “Modern VLSI Design: System on Chip”, 1st Edition, Pearson Education, 2009.
5. Samir Palnitkar “Verilog HDL a guide to Digital design and Synthesis”, 2nd Edition, Prentice Hall, 2003.

21EC306	COMMUNICATION NETWORKS	L	T	P	C
		3	0	2	4
COURSE OBJECTIVES: • To outline the division of network functionalities. • To explain the data link layer functionalities. • To apply the knowledge in routing and subnet process. • To summarize the flow control and congestion control algorithms. • To classify the different application layer protocols.					
UNIT I	INTRODUCTION TO LAYER ARCHITECTURE & PHYSICAL LAYER				9
Overview of Data Communications: Networks, Building Network and its types: Overview of Internet: Protocol Layering, OSI Mode: Physical Layer, Switching.					
UNIT II	DATALINK LAYER				9
Introduction to Data Link Layer: Link layer Addressing, Error Detection and Correction. Overview of Data link Control and Media access control: Flow and Error Control: Protocols, HDLC.					
UNIT III	NETWORK LAYER				9
Network layer services: Packet Switching:IPV4 Address: Routing, Unicast Routing, Algorithms, Protocols: Multicast Routing and its basics: Overview of Intra domain and interdomain protocols: Overview of IPv6 Addressing, Transition from IPv4 to IPv6.					
UNIT IV	TRANSPORT LAYER				9

Introduction to Transport layer: Protocols- User Datagram Protocols (UDP) and Transmission Control Protocols (TCP): Services, Features, TCP Connection, State Transition Diagram, Flow and Error control, Mobile TCP, Snooping TCP, Indirect TCP, Congestion Control, Congestion avoidance.		
UNIT V	APPLICATION LAYER	9
Application Layer Paradigms: Client Server Programming, World Wide Web and HTTP, DNS, Electronic Mail (SMTP, POP3, IMAP, MIME): Need for Cryptography and Network Security, Firewalls.		
TOTAL: 45 PERIODS		
LIST OF EXPERIMENTS:		
1. Implementation and Analysis of star and bus topologies. 2. Implementation of Stop and wait, Goback N and Selective repeat protocol 3. Configuration of IP address and implementation of basic networking commands. 4. Implementation of Distance vector routing algorithm. 5. Implementation of Link state routing algorithm. 6. Configuration and analysis of a network using Packet tracer software. 7. Implementation of an encryption and decryption algorithm using any programming language.		
TOTAL: 30 PERIODS		
COURSE OUTCOMES:		
At the end of the course, the learners will be able to CO1: Outline the layered architecture and functionalities of a network. CO2: Make use of Media Access Control protocols for error detection and flow control. CO3: Develop routing table to efficiently route data using routing protocols. CO4: Explain end to end data delivery protocols to improve congestion control and QoS. CO5: Summarize the functionalities of application layer protocols.		
TEXT BOOKS:		
1. Behrouz A. Forouzan, “Data communication and Networking”, 5th Edition, Tata McGraw Hill, 2017. 2. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, 6th		

Edition, Morgan Kaufmann Publishers, 2021. 3. William Stallings, “Data and Computer Communications”, 9th Edition, Pearson Education, 2013.
REFERENCES: 1. James F. Kurose, Keith W. Ross, “Computer Networking - A Top-Down Approach Featuring the Internet”, 7th Edition, Pearson Education, 2017. 2. Nader. F. Mir, “Computer and Communication Networks”, 2nd Edition, Pearson Prentice Hall Publishers, 2014. 3. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, 3rd Edition, Tata McGraw Hill, 2012.

21EC307	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES: • To gain knowledge about the basic programming concepts in verilog HDL. • To develop verilog code for combinational and sequential circuits. • To implement the programs in FPGA. • To simulate and synthesize the combinational and sequential circuits. • To develop CMOS inverter and inverting amplifiers.					
LIST OF EXPERIMENTS: 1. Design and Implementation of Logic Gates and Adders. 2. Design and Implementation of multipliers. 3. Design and Implementation of decoders, multiplexers, and comparators. 4. Design and Implementation of Flip-Flops. 5. Design and Implementation of Shift Registers. 6. Design and Implementation of ALU. 7. Design and simulate 4-bit synchronous counter using Flip-Flops. 8. Design and simulate Mealy and Moore state machines.					

9. Generate synthesis, timing and power analysis.
10. Design and Simulate a CMOS Differential Amplifiers.
TOTAL : 60 PERIODS
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Develop programs for basic combinational circuits. CO2: Utilize verilog HDL and simulate the sequential digital circuits. CO3: Demonstrate the logic modules using FPGA boards. CO4: Analyze the synthesis report and infer the utilization. CO5: Develop the analog CMOS circuits using SPICE.

SEMESTER VII

21EC401	MICROWAVE AND OPTICAL ENGINEERING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the characteristics of microwave passive components. • To illustrate microwave semiconductor devices. • To gain knowledge about the basic principles of microwave tubes and microwave measurements. • To analyze optical fiber transmission characteristics. • To understand the mechanism of optical sources and detectors.					
UNIT I	MICROWAVE PASSIVE COMPONENTS	9			
Microwave frequency range – significance of microwave frequency range – important properties & applications of microwaves – Microwave junctions – Tee junctions – Magic Tee – Rat race – Corners – bends and twists – Directional couplers – two hole directional couplers – Ferrites – Termination – Gyrator – Isolator – Circulator – Attenuator – Phase changer – S Matrix for microwave components – Cylindrical cavity resonators.					
UNIT II	MICROWAVE SEMICONDUCTOR DEVICES	9			

Microwave semiconductor devices – operation, characteristics and application of BJTs and FETs – power frequency limitations - Principles of tunnel diodes – Varactor and Step recovery diodes – Transferred Electron Devices – Gunn diode – Avalanche Transit time devices – Reed diode, IMPATT and TRAPATT devices. Filter design by insertion loss method – Butterworth and Chebyshev MIC Filters.		
UNIT III	MICROWAVE TUBES AND MEASUREMENT	9
Microwave tubes – High frequency limitations – Principle of operation of Multi cavity Klystron, Reflex Klystron, Traveling Wave Tube and Magnetron. Microwave measurements – power, wavelength, impedance, SWR, attenuation, Q and Phase shift measurements.		
UNIT IV	FUNDAMENTALS OF OPTICAL FIBERS	9
Ray theory of light transmission through a fiber – Total internal reflection – Acceptance angle – Numerical aperture – Skew rays – Electromagnetic mode theory of optical propagation – Step Index and Graded Index, Single Mode and Multi-Mode fibers – Attenuation in a fiber – Fiber bending Loss.		
UNIT V	OPTICAL SOURCES AND DETECTORS	9
Optical sources: Light Emitting Diodes – LED structures – surface and edge emitters, mono and hetero structures – internal quantum efficiency – injection laser diode structures – comparison of LED and ILD - Optical Power Launching and Coupling. Optical Detectors: PIN Photo detectors, Avalanche photo diodes, construction, characteristics and properties – Comparison of performance – Photo detector noise – Noise sources, Signal to Noise ratio – Detector response time.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Design passive microwave components. CO2: Demonstrate the working principles of semiconductor microwave devices CO3: Illustrate the principle of operation of microwave tubes and procedure to measure microwave power, wavelength, impedance, SWR, attenuation, Q and Phase shift. CO4: Analyze optical fiber transmission characteristics CO5: Analyze the various optical source materials and LED structures and photo detectors.		
TEXT BOOKS: 1. Samuel Y Liao, “Microwave Devices & Circuits”, 3 rd edition, Prentice Hall of India,		

2006.
2. Gerd Keiser, “Optical Fiber Communication”, 5 th Edition, McGraw Hill, 2014.
3. David M.Pozar, “Microwave Engineering”, 4 th Edition, Wiley India, 2013.
REFERENCES:
1. Annapurna Das and Sisir K Das, “Microwave Engineering”, 3 rd Edition, Tata McGraw Hill Inc., 2017.
2. J.Gower, “Optical Communication System”, 3 rd Edition, Prentice Hall of India, 2001.
3. John M. Senior, “Optical Fiber Communication”, 3 rd Edition, Pearson Education, 2009.

21EC403	MICROWAVE AND OPTICAL LABORATORY	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES: - To analyse the characteristics of microwave generators. - To summarize the performance measurement of microwave passive components. - To gain knowledge on ADS simulation tool. - To outline the characteristics of LED and Photo diode. - To analyze various losses of digital and analog optical link.					
LIST OF EXPERIMENTS: MICROWAVE EXPERIMENTS: - Mode characteristics of Reflex Klystron. - Characteristics of Gunn Diode. - VSWR, Frequency and Wavelength Measurement of microwave signal within waveguide. - Measurement of Directivity and Coupling Coefficient of Directional Coupler. - S - Parameter measurement of Isolator and Circulator. - S - Matrix Characterization of E-Plane Tee, H-Plane Tee and Magic Tee Junctions. - Gain Measurement of Horn Antenna. - Microstrip Patch Antenna Design using ADS. - Study of SDR kit. OPTICAL EXPERIMENTS: - DC characteristics of LED and PIN Photodiode.					

2. Measurement of Connector and Bending Losses. 3. Study of Fiber optic Analog and Digital Link. 4. Determination of Numerical Aperture in optical Fibers 5. Attenuation Measurement in Fibers
TOTAL: 60 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Compare the performance of different microwave generators CO2: Analyze the performance of passive microwave components. CO3: Interpret the characteristics of antennas using ADS package. CO4: Analyze the characteristics of optical sources and detectors. CO5: Examine various optical fiber links and their transmission losses.

21EC404	PROJECT WORK I	L	T	P	C
		0	0	4	2
COURSE OBJECTIVES: • To identify the problems in industries and social relevant applications. • To make use of innovative methods for problem identification. • To develop the prototype for the project. • To apply the real time for successful working. • To identify the platforms for the project explorations.					
METHOD OF EVALUATION: • The students in a group of 2 to 4 works on a topic approved by the head of the department and prepare a comprehensive project-I report after completing the work. • The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. • A project report is required at the end of the semester. • The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.					
TOTAL: 60 PERIODS					
COURSE OUTCOMES: At the end of the course, learners will be able to: CO1: Outline the problem identified in industries. CO2: Experiment with the innovative techniques. CO3: Make use of advanced tools for the solution.					

CO4: Select a suitable method for implementation. CO5: Analyze the developed prototype for future scope.

21EC405	PROJECT WORK II	L	T	P	C
		0	0	20	10
COURSE OBJECTIVES: • To organize the works related to project. • To solve a specific problem right from its identification and literature review till the successful solution of the same. • To develop the students in preparing project reports. • To build the students to face reviews and viva voce examination. • To plan project contest and journal publication.					
METHOD OF EVALUATION: • The students in a group of 2 to 4 works on a topic approved by the review committee under the guidance of the HoD and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. • The progress of the project is evaluated based on minimum of three reviews. • A project report is required at the end of the semester. • The project work is evaluated based on oral presentation, hardware/software results and the project report jointly by external and internal examiners.					
TOTAL: 300 PERIODS					
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Solve engineering problem with social relevance. CO2: Plan for writing report and viva voce examination. CO3: Make use of the project reports for publications. CO4: Choose a suitable methodology for a problem solving. CO5: Organize the works related to project implementation.					

PROFESSIONAL ELECTIVE COURSES

VERTICAL – I

RF CIRCUITS AND ANTENNA DESIGN

21PEC01	RF TRANSCEIVERS	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To outline the design considerations and architectures of a RF transceiver. • To analyze the performance of various RF amplifiers. • To explain the functionalities of RF power amplifiers. • To design RF mixers and oscillators. • To understand the design and packaging mechanism of RFIC.					
UNIT I	SPECIFICATIONS AND ARCHITECTURES	12			
Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise - Specification distribution over a communication link Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures - Transmitter: Direct upconversion, Two step upconversion.					
UNIT II	IMPEDANCE MATCHING AND AMPLIFIERS	12			
S-parameters with Smith chart - Passive IC components - Impedance matching networks Amplifiers: Common Gate, Common Source Amplifiers - OC Time constants in bandwidth estimation and enhancement. Power match, Noise match-Single ended, and Differential LNA.					
UNIT III	FEEDBACK SYSTEMS AND POWER AMPLIFIERS	12			
Feedback Systems: Stability of feedback systems: Gain and phase margin, Root Locus techniques - Time and Frequency domain considerations – Compensation. Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers.					
UNIT IV	MIXERS AND OSCILLATORS	12			
Mixer: characteristics - Non-linear based mixers: Quadratic mixers - Multiplier based mixers Single balanced and double balanced mixers - subsampling mixers. Oscillators: Colpitts oscillators - Resonators - Tuned Oscillators - Negative resistance oscillators - Phase noise.					

UNIT V	RFIC & PACKAGING	12
Transceiver architectures-Role of RFICs in Transceiver, Lower frequency design and RFIC design issues of RFICs in transceivers-Active/Passive device technologies for RFIC implementations-Modern RFIC chip sets for current wireless standards, Packaging techniques, High frequency measurement.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Apply the knowledge of RF electronics for characterizing RF Systems. CO2: Design different types of RF amplifiers. CO3: Illustrate the requirements and design procedure of RF power amplifiers. CO4: Analyze the performance of practical RF circuits. CO5: Design RFIC and understand the packaging techniques.		
TEXT BOOKS: 1. B.Razavi, “RF Microelectronics”, 2 nd Edition, Pearson Education, 2011. 2. T.Lee, “Design of CMOS RF Integrated Circuits”, 2 nd Edition, Cambridge, 2004. 3. Hooman Darabi, “Radio Frequency integrated circuits and design”, 2 nd Edition, Cambridge university press, 2020.		
REFERENCES: 1. David M Pozar, “Microwave Engineering”, 4 th Edition, John Wiley and Sons, 2011. 2. Jan Crols, Michiel Steyaert, “CMOS Wireless Transceiver Design”, Reprint of 1 st Edition, Springer-Verlag New York Inc., 2010. 3. John M. W. Rogers, John W. M. Rogers, Calvin Plett, “Radio Frequency Integrated Circuit Design”, 2 nd Edition, Arctech House, 2010.		

21PEC02	RF MEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: To explain the concept of MEMS technology.					

• To interpret the working principles of MEMS components. • To design the phase shifters and transmission lines using MEMS. • To demonstrate the characteristics of micro machined antennas. • To design RF MEMS using computer aided tools.		
UNIT I	INTRODUCTION TO RF MEMS	9
Introduction to RF MEMS: Application in wireless communications, space and defense applications, Benefits of Miniaturization and Scaling, RF MEMS in industry and academia, Actuation Mechanisms in MEMS: Piezoelectric, Electrostatic, Thermal, Magnetic		
UNIT II	MEMS COMPONENTS	9
MEMS Switch: Example of RF MEMS switches and applications, Mechanical design, Electromagnetic modeling (Capacitance, Loss, Isolation), Current research Tunable Capacitors and Inductors: Example of tunable capacitors and inductors and their applications in circuits, Effect of inductor layout, reduction of stray capacitance of planar inductor, Approaches for improving quality factor, Polymer based inductors, MEMS gap tuning, area tuning and dielectrictuning capacitors.		
UNIT III	PHASE SHIFTERS AND TRANSMISSION LINES	9
Types of phase shifters and their limitations, MEMS phase shifters: Switched delay line phase shifters, Distributed phase shifters, Polymer based phase shifters, Losses in transmission lines, Micro shield and membrane supported transmission lines – Radar applications.		
UNIT IV	MICROMACHINED ANTENNAS	9
Overview of microstrip antennas, Micromachining techniques to improve antenna performance, micro machined reconfigurable antennas, Micro fabrication Techniques: Materials Properties, Bulk and surface micromachining, Wet and dry etching Thin-film depositions (LPCVD, Sputtering, Evaporation), other techniques (LIGA, Electroplating)		
UNIT V	PACKAGING & CAD DESIGN	9
Packaging of RF MEMS: Role of MEMS packaging, Types of MEMS Packages, Reliability issues of MEMS packaging. Computer aided design of MEMS: Introduction to Commercial packages, Introduction and usage of Intellisuite and Coventorware, RF MEMS Switch simulation using Intellisuite, RF MEMS Phase shifter simulation.		
TOTAL : 45 PERIODS		

COURSE OUTCOMES:

At the end of the course, the learners will be able to

- CO1: Illustrate the concepts of RF MEMS mechanism.
- CO2: Design RF MEMS switches and passive components.
- CO3: Design RF phase shifters and transmission lines.
- CO4: Design an intelligent control based micromachining for antenna design.
- CO5: Analyze properties of RF MEMS using CAD tools for application specific designs.

TEXT BOOKS:

1. Tai- Ran Hsu, “MEMS and Microsystems Design and Manufacture”, 1st Edition, Tata McGraw Hill, 2017.
2. Shiban Kishen Koul, Sukomal Dey, “Radio Frequency Micro machined Switches, Switching Networks, and Phase Shifters”, CRC Press, 2019.
3. Vijay K.Varadan and K.J. Vinoy, K.A. Jose., “RF MEMS and their Applications”, John Wiley and Sons, 2011

REFERENCES:

1. Nitaigour Mahalik, “MEMS”, 1st Edition, Tata McGraw Hill, 2014.
2. Rai Chaoudhry, “MEMS and MOEMS Technology and Applications”, 2nd Edition, PHI Learning, 2012.
3. G.K.Anantha Suresh, K.J.Vinoy, K.N.Bhatt and V.K.Aatre, “Micro and Smart Systems”, 1st Edition, John Wiley & Sons, 2010.

21PEC03	RF TEST AND MEASUREMENT	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To gain knowledge about the basic principles of RF measurement. • To learn about equipments used for measurements. • To explain testing procedures for different RF devices. • To analyze the performance of antenna. • To study the basic principles EMI/EMC and Testing.					

UNIT I	INTRODUCTION	9
RF Systems and components – Need for Characterization, evaluation and Certification. RF measurement, Measurement Parameters- S parameters and power.		
UNIT II	EQUIPMENT FOR MEASUREMENT	9
Spectrum Analyzer- Principle, Measurement procedure, Network Analyzer- Principle, Measurement procedure, Calibration.		
UNIT III	RF DEVICE MEASUREMENT	9
S parameters for Devices - transmission lines, coupler, filters, circulators, resonator, antenna etc. Measurement with Network Analyzer, Amplifier testing, gain, phase noise and Noise margin measurement, Power measurement.		
UNIT IV	ANTENNA MEASUREMENT	9
Reflection coefficient, Return loss of different antennas, Measurement with Spectrum and Network Analyzer, Gain Measurement, Radiation pattern measurement in both Indoor and Anechoic chamber, Test ranges.		
UNIT V	EMI/EMC MEASUREMENT	9
Open field test, TEM cell for immunity test , Shielded anechoic chamber , EMI test receivers - EMI test wave simulators - EMI coupling networks - Line impedance stabilization networks - Feed through capacitors- Some International Precautionary Exposure Guidelines, EMF Measurement System, RF Exposure Measurements & Testing, Mobile phone SAR Measurements		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Explain the basics of RF measurement and related parameters. CO2: Explain the measurement techniques and procedure. CO3: Demonstrate the testing of RF components/systems and measurement of electromagnetic emission. CO4: Analyze the performance of RF components and systems CO5: Demonstrate the issues with EMI/EMC through RF testing.		
TEXT BOOKS: 1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas for all		

Applications”, 2 nd Edition, Tata McGraw-Hill, 2008.
2. David M.Pozar, “ Microwave Engineering”, 4 th Edition, Wiley India, 2013.
3. Scott A. Wartenberg, “RF measurements of die and packages”, Artech House, 2002.
REFERENCES:
1. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, 2 nd Edition, IEEE Press, New York, 2001.
2. Clayton Paul, “Introduction to Electromagnetic Compatibility”, 2 nd Edition, Wiley Interscience, 2010.
3. Agilent’s AppNote, “Fundamentals of RF and Microwave Power Measurement”.

21PEC04	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To explain the fundamentals of EMI and EMC. - To outline the basic principles of coupling. - To illustrate various EMI mitigation techniques. - To summarize the comprehensive insight about the current EMC standards. - To explain EMI test methods and equipments.					
UNIT I	BASIC THEORY				9
Introduction to EMI and EMC- Intra and inter system EMI-Elements of Interference-Sources and Victims of EMI- Conducted and Radiated EMI emission and susceptibility- Radiation hazards to humans- Various issues of EMC- EMC Testing categories - EMC Engineering Application.					
UNIT II	COUPLING MECHANISM				9
Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.					

UNIT III	EMI MITIGATION TECHNIQUES	9
Shielding - Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems – Filtering – EMI Suppression Cables – EMC connectors- EMC Gaskets – Isolation Transformers – Opto-Isolators - Transient and Surge Suppression devices.		
UNIT IV	STANDARDS AND REGULATIONS	9
Need for Standards - Generic/General Standards for Residential and Industrial environment - Basic Standards - Product Standards - National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC - Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.		
UNIT V	EMI TEST METHODS AND INSTRUMENTATION	9
Fundamental considerations - EMI Shielding effectiveness tests - Open field test, TEM cell for immunity test - Shielded anechoic chamber - EMI test receivers - EMI test wave simulators - EMI coupling networks - Line impedance stabilization networks -Feed through capacitors - Antennas- Current probes - MIL -STD test methods, Civilian STD test methods.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Infer the basic concepts of Electromagnetic Interference and Compatibility. CO2: Utilize various EMI coupling principles to achieve compatibility. CO3: Outline EMI mitigation techniques. CO4: Summarize the EMC standards and regulations in measurement techniques. CO5: Select EMI methods and equipments based on specific requirements.		
TEXT BOOKS 1. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, 2nd Edition, IEEE Press, New York, 2001. 2. Henry W. Ott, “Electromagnetic Compatibility Engineering”, 2nd Edition, John Wiley & Sons Inc, Newyork, 2009. 3. Xingcun Colin Tong, “Advanced Materials and Design for Electromagnetic Interference Shielding”, CRC Press, 2008		

REFERENCES:

1. Clayton Paul, "Introduction to Electromagnetic Compatibility", 2nd Edition, Wiley Interscience, 2010.
2. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", 1st Edition, John Wiley & Sons Inc., (Wiley Interscience Series), 1997.
3. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", 1st Edition, CRC Press, 2005.

21PEC05	ELECTROMAGNETIC METAMATERIALS	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To explain the concepts of left handed materials. • To design metamaterial transmission lines. • To learn about the structure of metamaterials. • To design metamaterial antennas. • To interpret the applications of metamaterials.					
UNIT I	LEFT HANDED MATERIALS AND THEIR PROPERTIES				12
Left-Handedness from Maxwell’s equations, Entropy conditions in dispersive media, Boundary conditions, Reversal of Doppler effect, Reversal of Snell’s law: Negative refraction, Reversal of Goos-Haenchen effect, Reversal of convergence and divergence in Convex and Concave lenses, Sub-wavelength diffraction, Fresnel coefficients.					
UNIT II	METAMATERIAL TRANSMISSION LINES				12
Ideal homogeneous CRLH TLs- equivalent MTM constitutive parameters, Balanced and Unbalanced resonances, LC network implementation: Transmission matrix analysis, Input impedance, Cutoff frequencies, Analytical dispersion relation, Bloch impedance. Experimental transmission characteristics, Conversion from transmission line to constitutive parameters.					
UNIT III	METAMATERIAL STRUCTURES AND ANALYSIS				12
Real distributed 1D CRLH structures: General design guidelines, Microstrip implementation, and parameters extraction, Two-dimensional MTMs: Eigen value problem, Negative					

Refractive Index (NRI) effects: Negative phase velocity, Negative refraction, Negative focusing, RH-LH interface surface plasmons. Distributed 2D structures.		
UNIT IV	METAMATERIAL ANTENNAS	12
Fundamental aspects of Leaky-Wave structures, Principle of leakage radiation, Uniform and periodic Leaky-Wave structures, Uniform LW structures, Periodic LW structures, Metamaterial Leaky-Wave structures. Backfire-to End fire (BE) Leaky-Wave (LW) antenna, Electronically scanned BE LW antenna: Electronic scanning principle, Electronic beamwidth control principle, Two-Dimensional structures: Two Dimensional LW radiation, Conical-Beam antenna, Full-Space scanning antenna, Dual-Band CRLH-TL resonating ring antenna.		
UNIT V	APPLICATION AND ADVANCES IN METAMATERIALS	12
Three-dimensional Isotropic LH MTMs, Optical MTMs, ‘Magnetless’ magnetic MTMs, Terahertz magnetic MTMs, Surface plasmonic MTMs, Antenna radomes and Frequency selective surfaces, Nonlinear MTMs, Active MTMs.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the properties of metamaterials. CO2: Construct metamaterial transmission lines. CO3: Design the metamaterial structures. CO4: Demonstrate the metamaterial inspired antennas. CO5: Select the metamaterials for advanced applications.		
TEXT BOOKS: 1. Christophe Caloz and Tatsuo Itoh, “Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications”, 1 st Edition, A John Wiley & Sons, Inc., Publication, 2006. 2. Tie Jun Cui, David Smith and Ruopeng Liu, “Metamaterials: Theory, Design, and Applications”, 1 st Edition, Springer, 2009. 3. Kazuaki Sakoda, “Electromagnetic Metamaterials Modern Insights Into Macroscopic Electromagnetic Fields”, Springer, Singapore, 2019.		
REFERENCES: 1. Douglas H. Werner and Do-Hoon K, “Transformation Electromagnetics and Metamaterials”, 1 st Edition, Springer-Verlag London, 2014.		

2.	Fajun Xiao, Ivan Rukhlenko, Weiren Zhu, Xingzhan Wei, "Theory and Applications of Electromagnetic Metamaterials", Frontiers Media SA, 2021.
3.	Nader Engheta, Richard W. Ziolkowski, "Metamaterials: Physics and Engineering Explorations" Wiley, 2006.

21PEC06	MODERN ANTENNA DESIGN	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To gain knowledge on various types of printed antennas. • To explain about wearable antennas. • To gain the knowledge about active integrated antennas. • To explain the reconfigurability function in antenna design. • To explore the theory of metamaterials and metasurfaces.					
UNIT I	PRINTED ANTENNAS	12			
Concepts of Printed antennas, Broadband microstrip patch antennas, Circularly polarized planar antennas, Enhanced gain patch antennas, Wideband compact patch antennas, Microstrip slot antennas, Microstrip planar monopole antenna, Patch antennas for multiband applications.					
UNIT II	WEARABLE ANTENNAS	12			
Overview of wearable systems and its characteristics, Antennas for wearable devices, Design requirements, Modeling and Characterization of wearable antennas, WBAN radio channel characterization and Effect of wearable antennas, Domains of operation, Sources on the human body, Compact wearable antenna for healthcare sensors.					
UNIT III	ACTIVE INTEGRATED ANTENNAS	12			
Active wearable antenna modules-Features, Electromagnetic characterization of fabrics and Flexible foam materials, Matrix-Pencil two-line method, Small-Band inverse planar antenna Resonator method. Substrate integrated waveguide technology.					
UNIT IV	RECONFIGURABLE ANTENNAS	12			
Reconfigurable methodologies: Frequency and Pattern Reconfigurabilities, Design considerations for reconfigurable systems, Reconfigurable planar/printed antenna configurations, Active reconfigurable systems.					

UNIT V	METAMATERIALS AND METASURFACES	12
Double negative properties, Structures, Design of metamaterial antennas, Multi-surface - Metasurface antennas, Metahorns, Metalenses, Analysis of metasurfaces.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Evaluate the performance of different printed antennas. CO2: Analyze the properties of wearable antennas. CO3: Apply EM characterization to active integrated antennas. CO4: Design reconfigurable antennas. CO5: Develop metamaterials and metasurfaces.		
TEXT BOOKS: 1. Debatosh Guha and Yahia M.M. Antar, “Microstrip and Printed Antennas”, 1st Edition, John Wiley & Sons, 2011. 2. Taming the Borg, “Moving Wearables into the Mainstream”, 1st Edition, Springer, 2008. 3. Hubregt.J.Visser “Antenna Theory and Applications” 1st Edition, John Wiley & Sons Ltd, New York, 2012.		
REFERENCES: 1. Eng Hock Lim and Kwok Wa Leung, “Compact Multifunctional Antennas for Wireless Systems”, 2nd Edition, John Wiley & Sons, 2012. 2. Zhi Ning Chen, “Antennas for Portable Devices”, 3rd Edition, John Wiley & Sons, 2007. 3. Warren L Stutzman and Gary A.Thiele, “Antenna Theory and Design”, 3rd Edition, John Wiley & Sons, 2013.		

21PEC07	SIGNAL INTEGRITY	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To acquire knowledge on fundamentals of electromagnetic for signal integrity, its importance for high speed applications.					

• To know the factors that affect signal integrity. • To explain the characteristics of dielectric materials. • To learn about differential signaling and modeling of transmission lines for high speed devices. • To illustrate physical transmission line model.		
UNIT I	FUNDAMENTALS OF SIGNAL INTEGRITY	9
The importance of signal integrity - new realm of bus design - Electromagnetic fundamentals for signal integrity - Maxwell equations common vector operators - wave propagations - Electrostatics – magnetostatics - Power flow and the poynting vector - Reflections of electromagnetic waves.		
UNIT II	CROSS TALK	9
Introduction - mutual inductance and capacitance-coupled wave equation - coupled line analysis – modal analysis - cross talk minimization signal propagation in unbounded conductive media - classic conductor model for transmission model.		
UNIT III	DI-ELECTRIC MATERIALS	9
Polarization of Dielectric - Classification of Dielectric material - frequency dependent dielectric material - Classification of Dielectric material fiber - Weave effect - Environmental variation in dielectric behavior - Transmission line parameters for loose dielectric and realistic conductors.		
UNIT IV	DIFFERENTIAL SIGNALING	9
Removal of common mode noise - Differential Cross talk - Virtual reference plane-Propagation of model voltages common terminology - drawbacks of differential signaling.		
UNIT V	PHYSICAL TRANSMISSION LINE MODEL	9
Introduction - non ideal return paths - Vias - IO design consideration - Push-pull transmitter – CMOS receivers - ESSD protection circuits - On chip Termination.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:

At the end of the course, the students will be able to

- CO1: Outline the concept of signal integrity using electromagnetic theory, vector functions
- CO2: Illustrate crosstalk that affects the integration.
- CO3: Explain the properties of dielectric materials
- CO4: Analyze differential signaling
- CO5: Demonstrate a physical model for transmission lines

TEXT BOOKS:

1. Stephen H. Hall, Howard L. Heck, "Advanced Signal Integrity for High-Speed Digital Designs", Wiley IEEE Press, 2009.
2. James Edgar Buchanan, "Signal and power integrity in digital systems: TTL, CMOS, and BiCMOS ", Mc Graw Hill, 1996.
3. Stephen C. Thierauf, "Understanding Signal Integrity", Pages displayed by permission Artech Publishing House, 2011.

REFERENCES:

1. Greg Edlund, "Timing Analysis and Simulation for Signal Integrity Engineers", Prentice Hall of India, 2008.
2. Eric Bogatin, "Signal and Power Integrity - Simplified", 2nd Edition, Prentice Hall of India, 2010.
3. Mike Peng Li, "Jitter, Noise and Signal Integrity at High-Speed", Prentice Hall of India, 2008.

VERTICAL II

SIGNAL AND IMAGE PROCESSING

21PEC08	STOCHASTIC SIGNAL PROCESSING	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To explain the concepts of discrete random signal processing. • To illustrate the various parametric and non-parametric spectrum estimation methods. • To summarize the concepts behind linear estimation and prediction techniques. • To gain knowledge about FIR adaptive filtering techniques. • To summarize the multirate digital signal processing techniques.					
UNIT I	DISCRETE RANDOM SIGNAL PROCESSING				12
Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval’s theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations.					
UNIT II	SPECTRAL ESTIMATION				12
Estimation of spectra from finite duration signals, Nonparametric methods -Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods – ARMA, AR and MA model based spectral estimation, Solution using Levinson-Durbin algorithm.					
UNIT III	LINEAR ESTIMATION AND PREDICTION				12
Linear prediction – Forward and Backward prediction, Solution of Prony’s normal equations, Least mean-squared error criterion, Wiener filter for filtering and prediction, FIR and IIR Wiener filters, Discrete Kalman filter					
UNIT IV	ADAPTIVE FILTERS				12
FIR adaptive filters – adaptive filter based on steepest descent method- Widrow-Hopf LMS algorithm, Normalized LMS algorithm, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise cancellation, RLS adaptive algorithm.					

UNIT V	MULTIRATE DIGITAL SIGNAL PROCESSING	12
Mathematical description of change of sampling rate – Interpolation and Decimation, Decimation by an integer factor, Interpolation by an integer factor, Sampling rate conversion by a rational factor, Polyphase filter structures, Multistage implementation of multirate system, Application to subband coding – Wavelet transform.		
TOTAL : 60 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Explain the fundamental concepts of discrete random signal processing. CO2: Apply various parametric and non parametric techniques to estimate the spectrum. CO3: Develop algorithms for linear estimation and prediction techniques for processing signals. CO4: Outline the various adaptive filtering techniques. CO5: Summarize the working principles of multirate digital signal processing.		
TEXT BOOKS: 1. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, 2 nd Edition, John Wiley and Sons, Inc, Singapore, 2002 2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, 4 th Edition, Pearson Education, 2002 3. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: A Computer-based Approach, Vol. 2, McGraw-Hill Higher Education, 2006		
REFERENCES: 1. D.E. Dudgeon and RM. Mersereau, “Multidimensional Digital Signal Processing”, 2 nd Edition, Prentice Hall Professional Technical Reference, 2008. 2. C.Sidney Burrus, Ramesh Gopinath and Haito Guo, “Introduction to Wavelets and Wavelet Transform”, 16 th Edition, Prentice Hall, 2018. 3. Lawrence R.Rabiner and Bernard Gold, “Theory and Application of Digital Signal Processing” 1 st Edition, Prentice-Hal, 2007		

21PEC09	DIGITAL IMAGE PROCESSING	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To illustrate digital image fundamentals. • To explore various image enhancement techniques in spatial and frequency domains. • To summarize the concepts of degradation function, restoration techniques and segmentation algorithms. • To explain different image compression techniques. • To outline image representation and recognition methods.					
UNIT I	FUNDAMENTALS OF DIGITAL IMAGE	12			
Fundamentals of Image processing: Elements of digital image processing systems, Elements of visual perception, Image sampling and quantization, Basic Relationships between pixels, Color image fundamentals - RGB, HSI models. Image Transforms: DFT, DCT.					
UNIT II	IMAGE ENHANCEMENT	12			
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	IMAGE RESTORATION AND SEGMENTATION	12			
Image Restoration: Degradation model. Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters– Inverse Filtering – Wiener filtering. Image Segmentation: Detection of discontinuities-Edge linking and boundary detection-Thresholding – Optimal thresholding-Region based segmentation-Region growing-Region splitting and merging.					
UNIT IV	IMAGE COMPRESSION	12			
Image Compression Model, Huffman coding, Arithmetic coding, LZW coding, Run Length coding, Lossless and Lossy predictive coding, transform coding, JPEG and MPEG compression standards.					

UNIT V	IMAGE REPRESENTATION AND RECOGNITION	12
Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments –Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors –Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.		
TOTAL : 60 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Relate the fundamental concepts of digital image processing. CO2: Illustrate the image enhancement techniques in spatial and frequency domains. CO3: Apply the concepts of restoration and segmentation algorithms on images. CO4: Select appropriate image compression techniques for various applications. CO5: Summarize different image representation techniques and recognition methods.		
TEXT BOOKS: 1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 4 th Edition, Pearson Ed., 2018. 2. Anil Jain K. “Fundamentals of Digital Image Processing”, 3 rd Edition, PHI Learning, 2011. 3. William K. Pratt, “Digital Image Processing”, 2 nd Edition, John Wiley, New York, 2002.		
REFERENCES: 1. Kenneth R. Castleman, “Digital Image Processing”, Pearson, 2006. 2. Rafael C. Gonzalez and Richard E. Woods, Steven Eddins, “Digital Image Processing using MATLAB”, 6 th Edition, Pearson Education, Inc., 2011. 3. Milan Sonka et al “Image processing, analysis and machine vision”, 2 nd Edition, Brookes Cole, Vikas Publishing House, 1999.		

21PEC10	SPEECH PROCESSING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the speech production mechanism and the various speech analysis techniques and speech models. • To interpret the speech compression techniques. • To comprehend the speech recognition techniques. • To know the speaker recognition techniques. • To understand the text to speech synthesis techniques.					
UNIT I	SPEECH SIGNAL CHARACTERISTICS & ANALYSIS	9			
Speech production process - speech sounds and features- Phonetic Representation of Speech – representing, speech in time and frequency domains - Short-Time Analysis of Speech – Short Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception					
UNIT II	SPEECH COMPRESSION	9			
Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP)					
UNIT III	SPEECH RECOGNITION	9			
LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM- subword unit model based on HMM- language models for large vocabulary speech recognition - Overall recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition					
UNIT IV	SPEAKER RECOGNITION	9			
Acoustic parameters for speaker verification- Feature space for speaker recognition-similarity measures- Text dependent speaker verification-Text independent speaker verification techniques					

UNIT V	TEXT TO SPEECH SYNTHESIS	9
Text to speech synthesis(TTS)-Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Interpret Speech Characteristics and Speech Analysis Techniques. CO2: Demonstrate Speech Compression techniques. CO3: Analyze speech recognition techniques. CO4: Outline the speaker recognition systems. CO5: Explain the text to speech synthesis systems.		
TEXT BOOKS: 1. L. R. Rabiner and R. W. Schafer, “Introduction to Digital Signal Processing, Foundations and Trends in Signal Processing”, Vol.1, Nos. 1-2 (2007) 1- 194. 2. Ben Gold and Nelson Morgan “Speech and Audio signal processing- processing and perception of speech and music”, 2 nd Edition, John Wiley and Sons, 2011. 3. Sadaoki Furui, Digital Speech Processing, Synthesis And Recognition, 2nd Edition, CRC Press, 2018		
REFERENCES: 1. Dan, Jurafsky, James H . Martin, “Speech And Language Processing- An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 2 nd Edition, Pearson Prentice Hall, 2009. 2. Joseph Mariani, “Language and Speech Processing”, 1 st Edition, Wiley, 2009. 3. Donglos O Shanhnessy “Speech Communication: Human and Machine”, 2 nd Edition, University Press 2001.		

21PEC11	SOFTWARE DEFINED RADIO	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To outline radio frequency standards. - To implement different types of RF systems. - To demonstrate multi rate signal processing and digital generation of signals. - To gain knowledge about data converters and smart antennas. - To infer digital hardware and software choices.					
UNIT I	INTRODUCTION TO SDR	9			
Introduction to software Radio concepts: Need for software Radios, Definition of software Radio, Characteristics and Benefits. Design Principles. Case studies: SPEAK easy, JTRS, SDR-3000.					
UNIT II	IMPLEMENTATION OF RADIO FREQUENCY SYSTEMS	9			
The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.					
UNIT III	MULTIRATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS	9			
Sample rate conversion principles. Digital filter Banks. Timing recovery in Digital Receivers using Multi rate Digital filters. Approaches to Direct Digital Synthesis. Analysis of spurious signal Band pass signal generation, Generation of Random sequences.					
UNIT IV	DATA CONVERTERS AND SMART ANTENNAS	9			
Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas- Hardware implementation of Smart Antennas.					
UNIT V	DIGITAL HARDWARE AND SOFTWARE CHOICES	9			
DSP Processors, FPGA, ASIC. Tradeoffs, Object oriented programming, Object Brokers, GNU Radio-USRP.					
TOTAL : 45 PERIODS					

COURSE OUTCOMES:

At the end of this course, learners will be able to

CO1: Interpret Software radio concepts and case studies.

CO2: Illustrate the implementation of RF systems.

CO3: Infer the multirate signal processing concept.

CO4: Explain the data converters and smart antennas.

CO5: Summarize the choices of digital hardware and software.

TEXT BOOKS:

1. Jeffrey H.Reed, "Software Radio: A Modern Approach to Radio Engineering", 1st Edition, Prentice Hall, 2002.
2. Joseph Mitola III, "Software Radio Architecture: Object oriented Approaches to Wireless System Engineering", 1st Edition, Wiley-Inter Science, 2004.
3. Walter H.W. Tuttlebee, Software Defined Radio - Enabling Technologies, 1st Edition, Wiley, 2002

REFERENCES:

1. Walter H.W.Tuttlebee, "Software Defined Radio-Enabling Technologies, 1st Edition, Wiley, 2002.
2. S.Shanmugavel, M.A.Bhagyaveni and R.Kalidoss, "Cognitive Radio-An Enabler for Internet of things", 1st Edition, River Publishers, 2017.
3. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, Software Defined Radio: Architectures, Systems and Functions, 1st Edition, Wiley, 2002.

21PEC12	DSP ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To introduce the basics of programmable DSPs. • To illustrate the concepts of TMS320C5X. • To know the basics of TMS320C6X digital signal processors. • To provide in depth knowledge in ADSP processors. • To understand the concepts of advanced processors.					

UNIT I	FUNDAMENTALS OF PROGRAMMABLE DSPs	9
Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals, Speed Issues, Features for External interfacing.		
UNIT II	TMS320C5X PROCESSOR	9
Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.		
UNIT III	TMS320C6X PROCESSOR	9
Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.		
UNIT IV	ADSP PROCESSORS	9
Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.		
UNIT V	ADVANCED PROCESSORS	9
Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to - CO1: Illustrate the basic architecture and programming concepts of DSP processor. - CO2: Develop assembly language coding in TMS 320C5X. - CO3: Develop ALP in TMS 320C6X processors. - CO4: Apply DSP algorithms using ADSP processors. - CO5: Analyze the features of various advanced processors.		

TEXT BOOKS:

1. B.Venkataramani and M.Bhaskar, “Digital Signal Processors – Architecture, Programming and Applications”, 1st Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
2. Avtar Singh and S. Srinivasan, “Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx”, 1st Edition, Cengage Learning India Private Limited, Delhi 2012.
3. Lapsley et al., “DSP Processor Fundamentals, Architectures & Features”, 1st Edition, S. Chand & Co, 2000.

REFERENCES:

1. Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, 1st Edition, A John Wiley & Sons, Inc., Publication, 2005.
2. J.G. Proakis & D.G.Manolokis, “Digital Signal Processing – Principles, Algorithms Applications”, 3rd Edition, PHI, 2005.
3. User guides Texas Instruments, Analog Devices and NXP.

21PEC13	WAVELETS AND MULTI RESOLUTION TRANSFORMS	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To outline the fundamental concepts of wavelet transforms. • To explain multi resolution concepts. • To demonstrate the wavelet system design. • To be familiar with the different wavelet families and applications. • To interpret the applications of various wavelets.					
UNIT I	INTRODUCTION TO WAVELETS	12			
Introduction to multi-rate signal processing- Decimation and Interpolation, Quadrature mirror filters, Sub-band coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous wavelet transform, Time frequency representation, Wavelet system and its characteristics, Orthogonal & Orthonormal functions and function space.					

UNIT II	MULTI RESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM	12
Multi resolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks-Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.		
UNIT III	WAVELET SYSTEM DESIGN	12
Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.		
UNIT IV	WAVELET FAMILIES	12
Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.		
UNIT V	APPLICATIONS OF WAVELETS	12
Denoising of Signals and Images, Image enhancement, Edge detection, Image fusion, Image compression, Wavelet based feature extraction.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the relation between vector and signal concepts. CO2: Outline multi resolution processes. CO3: Analyze the wavelet systems. CO4: Examine various continuous and discrete wavelet transforms. CO5: Select the wavelets for specific applications.		
TEXT BOOKS: 1. Raguveer M Rao and Ajith S. Bopardikar, “Wavelet transforms – Introduction to theory and applications”, 6 th Edition, Addison Wesley, 2012 2. K.P.Soman and KL Ramachandran, “Insight into wavelets from theory to practice”, 20 th Edition, PHI, 2008		

3. C.Sidney Burrus, Ramesh Gopinath and Haito Guo, “Introduction to Wavelets and Wavelet Transform”, 16 th Edition, Prentice Hall, 2018
REFERENCES: 1. G.Strang and T.Nguyen, “Wavelet and filter banks” 1st Edition, Wesley and Cambridge Press, 2008. 2. P.P.Vaidyanathan, “Multi-rate systems and filter banks”, 8th Edition, Prentice Hall 1993 3. S.Mallet, “A Wavelet tour of Signal Processing”, 1st Edition, Academic Press 1998

21PEC14	MULTIMEDIA COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To illustrate the basic ideas of compression algorithms related to multimedia components such as text, speech, audio, image and video. • To know about the principles and standards in text compression. • To infer the use of image compression in multimedia processing applications. • To explain the concept of audio compression. • To explore the video compression and its applications.					
UNIT I	FUNDAMENTALS OF COMPRESSION	9			
Introduction to multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression algorithms - Elements of information theory – Error free compression – Lossy compression.					
UNIT II	TEXT COMPRESSION	9			
Huffman coding – Adaptive Huffman coding - Arithmetic coding – Shannon-Fano coding Dictionary techniques – LZW family algorithms.					
UNIT III	IMAGE COMPRESSION	9			
Image compression: Fundamentals – Compression standards – JPEG standard – Sub-band coding – Wavelet based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.					

UNIT IV	AUDIO COMPRESSION	9
Audio compression techniques – μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Applications to speech coding – G.722 – MPEG audio – Progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.		
UNIT V	VIDEO COMPRESSION	9
Video compression techniques and standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – DVI real time compression – Current trends in compression standards.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Explain the requirement of compression in different real time applications. CO2: Select relevant techniques for text compression. CO3: Experiment with various image compression algorithms. CO4: Compare the performance of audio compression techniques. CO5: Illustrate the different standards applicable for video compression.		
TEXT BOOKS: 1. David Solomon, “Data Compression – The Complete Reference”, 4 th Edition, Springer Verlag, New York, 2006. 2. Darrel Hankerson, Greg A Harris and Peter D Johnson, “Introduction to Information Theory and Data Compression”, 2 nd Edition, Chapman and Hall, CRC Press, 2003. 3. Khalid Sayood, “Introduction to Data Compression”, Morgan Kauffman Harcourt India, 3 rd Edition, 2010.		
REFERENCES: 1. Mark S. Drew and Ze-Nian Li, “Fundamentals of Multimedia”, 1 st Edition, PHI, 2009. 2. Peter Symes, “Digital Video Compression”, 1 st Edition, McGraw Hill Publishers, 2004. 3. Yun Q. Shi and Huifang Sun, “Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals”, CRC Press, 2003.		

VERTICAL III

BIO MEDICAL TECHNOLOGIES

21PEC15	WEARABLE DEVICES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the real time applications and scope of wearable technology. • To explain the usage of fabrics in wearable devices. • To interpret the communication in wearable systems. • To design remote and rehabilitation systems. • To demonstrate the applications of smart textiles.					
UNIT I	INTRODUCTION TO WEARABLE DEVICES				9
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.					
UNIT II	SMART FABRICS				9
Introduction, Sensing fabrics, Actuating fabrics, smart fabric applications – Health care, motion capture and kinaesthetic interfaces, Conductive textiles, Performance of electrically conductive fabrics, smart textiles – Manufacturing and applications.					
UNIT III	WEARABLE COMPUTING SYSTEMS				9
Electronic textiles- Significance, Electrical characterization of textile networks, Smart clothing concept, model, Data transfer in smart clothing, Implementations for communication, dematerialization of information, Technology enablers.					
UNIT IV	KNITTED ELECTRONIC TEXTILES				9
Fibers to Textile Sensors, Interlaced Network, Physiological State Monitoring, Biomechanical Sensing, Platforms for Remote Monitoring, System for Remote Rehabilitation, Emotional State Assessment, Woven Electronic Textiles – applications.					

UNIT V	SMART TEXTILE SUIT	9
Principle of capture system – optical motion, Inertial motion, Textile Goniometer, Modality of measurement, applications – Rehabilitation: Stroke patient monitoring, Multisensorial Platform for Ambient and Assistance Living, Future prospects.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Illustrate the need and design requirements for wearable systems. CO2: Interpret the significance of smart fabric technology. CO3: Demonstrate wearable computing systems. CO4: Summarize the existing technology through demonstrations. CO5: Design the smart fabric wearable systems for real time applications.		
TEXT BOOKS: 1. Subhas C. Mukhopadhyay, “Wearable Electronics Sensors-For Safe and Healthy Living”, 1 st Edition, Springer International Publishing, 2015. 2. Edward Sazonov, Michael R Neuman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 1 st Edition, Elsevier, 2014. 3. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012.		
REFERENCES: 1. Xiaoming Tao, “Wearable electronics and photonics”, Woodhead Publishing Ltd and CRC Press LLC, 2016. 2. “Seamless Healthcare Monitoring Advancements in Wearable, Attachable, and Invisible Devices”, Springer, 2018. 3. Andreas Lymberis, Danilo de Rossi , “Wearable eHealth systems for Personalized Health Management - State of the art and future challenges” IOS press, The Netherlands, 2004.		

21PEC16	HUMAN ASSIST DEVICES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To interpret the various mechanical techniques that will help in assisting the heart functions. - To explain the working principles and parameters of the dialysis unit. - To outline the different types of hearing aids. - To infer various orthotic devices and prosthetic devices to overcome orthopedic problems. - To discuss the sensory impairments and its substitutions.					
UNIT I	CARDIAC ASSIST DEVICES	9			
Principle of External counter pulsation techniques, intra-aortic balloon pump, Cardiac catheterization, cardio pulmonary resuscitation, prosthetic heart valves					
UNIT II	HEMODIALYSERS	9			
Artificial kidney, Dialysis action, hemodialysis unit, membrane dialysis, portable dialyzer monitoring and functional parameters					
UNIT III	HEARING AIDS	9			
Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.					
UNIT IV	PROSTHETIC AND ORTHOTIC DEVICES	9			
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices					
UNIT V	SENSORY AUGUMENTATION AND SUBSTITUTIONS	9			
Classification of visual impairments, Prevention and cure of visual impairments, Visual augmentation, Tactile vision Substitution, Auditory substitution and augmentation, Assistive device for visual impaired.					
TOTAL: 45 PERIODS					

COURSE OUTCOMES:

At the end of the course, the learners will be able to

- CO1: Interpret various mechanical techniques that will help in assisting the heart functions.
- CO2: Demonstrate the working principles and parameters of the dialysis unit.
- CO3: Illustrate the characteristics of hearing aids.
- CO4: Infer the various orthotic devices and prosthetic devices to overcome orthopedic problems.
- CO5: Summarize the sensory impairments and its substitutions.

TEXT BOOKS:

1. John G. Webster “ Encyclopedia of medical devices and instrumentation” Vol.II, III, IV,V, 3rd Edition, Wiley Interscience, 2006.
2. D.S. Sunder, “Rehabilitation Medicine”, 3rd Edition, Jaypee Medical Publication, 2010.
3. R Chinnathurai ,”Short Textbook of Prosthetics and Orthotics”, Jaypee Brothers Medical Publishers (P) Ltd, 2010.

REFERENCES:

1. Paul A. Iaizzo “Hand book of cardiac Anatomy, Physiology and Devices” 2nd Edition, Springer, 2012.
2. Jeffrey H. Shuhaiber, “Ventricular assist devices”, 1st Edition, Intech publications, 2014.
3. R.S. Khandpur, “Handbook of Biomedical Instrumentation”, 2nd Edition ,Tata McGraw Hill, 2003.

21PEC17	THERAPEUTIC EQUIPMENTS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the devices for measurement of cardiology. • To illustrate the recording and measurement of EEG. • To demonstrate EMG recording unit and Biomechanical measurement.					

• To explain laser-based bio-medical diagnostic equipments. • To explore the concepts of sensory measurements.		
UNIT I	CARDIAC EQUIPMENTS	9
Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker- Internal and External Pacemaker- Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.		
UNIT II	NEUROLOGICAL EQUIPMENTS	9
Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential- Visual, Auditory and Somato sensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.		
UNIT III	MUSCULAR AND BIOMECHANICAL MEASUREMENTS	9
Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb position		
UNIT IV	LASER BASED BIO-MEDICAL EQUIPMENTS	9
Lasers in Medicine – Types, Tissue reactions. Lasers in ophthalmology, Flow Cytometry, Endoscopy, Minimally Invasive Laparoscopy, Laser Micro irradiation, Laser Doppler Velocimetry, Neurosurgical Laser Techniques. IR and UV lamp – application		
UNIT V	SENSORY MEASUREMENT	9
Psycho physiological Measurements – polygraph, Basal Skin Resistance (BSR), Galvanic Skin Resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:

At the end of the course, the learners will be able to

- CO1: Outline the working and recording setup of basic cardiac equipment.
- CO2: Infer the working and recording of basic neurological equipment.
- CO3: Illustrate the recording of diagnostic and therapeutic equipment's related to EMG.
- CO4: Explain laser based diagnostic equipment in medical.
- CO5: Demonstrate the measurement techniques of sensory responses.

TEXT BOOKS:

1. Leslie Cromwell, Fred J.Weibell and Erich A.Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education India, 2015.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, New Delhi, 2014.
3. John G.Webster, "Medical Instrumentation Application and Design", 4th Edition, John Wiley and Sons, New York, 2009.

REFERENCES:

1. Myer Kutz, "Biomedical Engineering & Design Handbook: Volume 2", 2nd Edition, McGraw- Hill Publisher, 2009.
2. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, John Wiley and Sons, Reprint 2008.
3. Antony Y.K.Chan, "Biomedical Device technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", 4th Edition, Pearson Education, 2014.

21PEC18	MEDICAL IMAGING SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the principles of radiographic equipments. • To demonstrate the types of CT imaging techniques.					

• To summarize the different types of Radio Isotopic Imaging techniques. • To know the principles of Ultra Sound Imaging systems. • To gain knowledge about MRI systems.		
UNIT I	PRINCIPLES OF RADIO GRAPHIC EQUIPMENT	9
X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy construction of image Intensifier tubes, angiographic setup, mammography, digital radiography, DSA.		
UNIT II	COMPUTED TOMOGRAPHY	9
Need for sectional images, Principles of sectional scanning, Generation in CT, CT detectors, Methods of Reconstruction-Iterative, Back projection, convolution and Back-Projection and central slice theorem, Artifacts, Principle of 3D imaging		
UNIT III	RADIO ISOTOPIC IMAGING	9
Alpha, Beta and Gamma radiation, Radiation detectors, Radio isotopic imaging equipment, Radio nuclides for imaging, Gamma camera, scanners, Positron Emission tomography, SPECT, PET/CT.		
UNIT IV	ULTRA SOUND IMAGING SYSTEMS	9
Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulse dexcitation, Transducers and imaging systems, Scanning methods, Imaging Modes, Principle and theory of image generation, Applications. Doppler Ultrasound, Ultrasound Image Quality and Artifacts.		
UNIT V	MAGNETIC RESONANCE IMAGING	9
NMR, Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI Instrumentation, MR Artifacts, Magnetic Resonance Spectroscopy and Functional MRI Case Study.		
TOTAL : 45 PERIODS		

COURSE OUTCOMES:

At the end of this course, learners will be able to

CO1: Discuss the principle and working of various radiographic equipments.

CO2: Explain the tomography concept and image reconstruction techniques.

CO3: Illustrate the concept of radio isotopic imaging techniques.

CO4: Describe the basic principle involved in Ultrasound Imaging technique.

CO5: Outline the basic principle and working of Magnetic resonance imaging technique.

TEXT BOOKS:

1. Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt, John M.Boone, The Essential Physics of Medical Imaging, Lippincott Williams and Wilkins; Fourth Edition, 2020.
2. D.N.Chesney and M.O.Chesney, Radiographic imaging, CBS Publications, 4th Edition, 2021.
3. Andreas Maier, Joachim Hornegger, Stefan Steid, Vincent Christlein, “Medical Imaging Systems-An Introductory Guide”, Springer International Publishing, 2018.

REFERENCES:

1. Donald W.McRobbice, Elizabeth A.Moore, Martin J.Grave and Martin R.Prince, MRI from picture to proton, 3rd Edition, Cambridge University press, New York, 2017.
2. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, New York, 2nd edition 2008.
3. Jerry L.Prince and Jonathan M.Links, Medical Imaging Signals and Systems-Pearson Education Inc, 2014.

21PEC19	HUMAN COMPUTER INTERFACE	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To learn the basic concepts of HCI. • To explain the basics of screen design. • To gain knowledge about the components of window. • To explore the evaluation techniques of the software.					

To know the various models of HCI.		
UNIT I	INTRODUCTION TO HCI	9
Introduction: Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design. The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.		
UNIT II	SCREEN DESIGNING	9
Design process – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds- business junctions. Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.		
UNIT III	COMPONENTS	9
Windows – New and Navigation schemes selection of window, selection of devices based and screen-based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.		
UNIT IV	EVALUATION TECHNIQUES	9
HCI in the software process, The software life cycle -Usability engineering Iterative design and prototyping -Design Focus: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics HCI patterns Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles Multi-modal interaction		
UNIT V	MODELS OF HCI	9
Cognitive models Goal and task hierarchies Design Focus-GOMS saves money Linguistic models -Challenge of display-based systems Physical and device models Cognitive architectures Ubiquitous computing and augmented realities Ubiquitous computing applications research Design Focus-Ambient Wood – augmenting the physical Virtual and augmented reality Design Focus: Shared experience Design Focus-Applications of augmented reality Information and data visualization- Design Focus- Getting the size right.		

TOTAL: 45 PERIODS	
COURSE OUTCOMES: On successful completion of this course, the student will be able to • Outline the basic concepts of HCI. • Illustrate the screen design theory of human interaction. • Summarize the various components of HCI. • Interpret the available evaluation techniques. • Explain the models of HCI.	
TEXT BOOKS: 1. Wilbert O Galitz, "The essential guide to user interface design", John Wiley & Sons, 2007. 2. Alan Dix, Janet Finckay, Gregory Abowd, Russell Beaulieu, "Human – Computer Interaction", Pearson Education, 2009 3. Varun Bajaj, G R Sinha, "Artificial Intelligence – Based Brain Computer Interface", Elsevier Science, 2022.	
REFERENCES: 1. Ben Shneiderman, "Designing the user interface", 5th Edition, Pearson Education, 2010. 2. Prece, Rogers, Sharps, "Interaction Design", 5th Edition, Wiley Dream tech, 2019. 3. Soren Lauesen, "User Interface Design", Pearson Education, 2003.	

21PEC20	WIRELESS BODY AREA NETWORKS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the fundamental concepts of wireless sensor networks. • To explore the design concepts of BAN and WBAN. • To be familiar with sensor networking protocols and technologies. • To introduce the topologies and protocols of WBAN. • To develop methodologies for health care applications.					

UNIT I	OVERVIEW OF WIRELESS SENSOR NETWORKS	9
Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Enabling Technologies for Wireless Sensor Networks – Operating Systems – Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.		
UNIT II	DESIGN REQUIREMENT OF BAN AND WBAN	9
BAN Positioning- Architecture of BAN- Requirements of BAN- BAN Standardization - Media Access Control (MAC) - Frame Processing- Physical Layer (PHY) - Application of BAN - Design Requirement of WBAN - WBAN Reference architecture - Software frameworks for programming WBAN- Hardware Development and systems for WBAN.		
UNIT III	NETWORKING OF SENSORS	9
Physical (PHY) layer technologies – Narrow band and UWB – Medium access control (MAC) technologies for WBAN – Unified MAC design independent of underlying PHY technologies; Standardization with IEEE802.15.6, IEEE 11073, and ETSI eHealth Project.		
UNIT IV	WBAN TECHNOLOGIES	9
WBAN Network topologies and configurations-Basics Medium Access Control protocols – Scheduled protocols-Random Access protocols-Hybrid MAC protocols		
UNIT V	WIRELESS SENSOR NETWORKS FOR HEALTHCARE APPLICATIONS	9
General approach to WSN in Healthcare – Key Principles, Methodology – Architecting WSN solutions for Healthcare – Hardware, Firmware and Software Choices.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Illustrate the characteristics of wireless sensor networks. CO2: Outline the fundamentals of BAN and WBAN. CO3: Summarize the salient features of Wireless Body Area Networks. CO4: Relate the topologies and protocols of WBAN. CO5: Interpret the approaches of wireless sensor networks for healthcare applications.		

TEXTBOOKS:

1. Kazem sohraby, Daniel Minoli and Taiebznati , “Sensor Networks: Technology, Protocols, and Applications”, 1st Edition, Wiley Interscience, 2010.
2. Mehmet R. Yuce and Jamil Khan, “Wireless Body Area Networks: Technology, Implementation, and Applications”, 1st Edition, CRC press, 2012.
3. Kaveh Pahlavan and Prasanth Krishnamoorthy, “Principles of Wireless Networks”, 1st Edition, Pearson Education, 2013.

REFERENCES:

1. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, Springer, 2003.
2. Huan-Bang Li, Kamyar Yazdandoost, and Bin Zhen, “Wireless Body Area Network”, River Publishers, Series in Information Science and Technology, 2010.
3. R. Maheswar, G. R. Kanaga Chidambaresan, R. Jayaparthiy and Sabu M. Thampi, “Body Area Network Challenges and Solutions”, Springer 2019.
4. Mohammed Ilyas and Imad Mahgoub, “Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems”, CRC Press, 2004.

21PEC21	BIO MEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To know about the fabrication process of Microsystems. • To explore the operation of mechanical and thermal sensors. • To outline the working of electrostatic and piezoelectric sensors. • To gain knowledge about the equations governing the Microsystems. • To study about application of Bio MEMS.					
UNIT I	MEMS AND MICROSYSTEMS	9			
Typical MEMs and Microsystems, materials for MEMS - active substrate materials- Silicon and its compounds, Silicon piezo resistors, Gallium Arsenide, quartz, polymers. Micromachining- photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA					

UNIT II	MECHANICAL AND THERMAL SENSORS AND ACTUATORS	9
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor		
UNIT III	ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS	9
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.		
UNIT IV	MICROFLUIDIC SYSTEMS	9
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, micro fluid dispenser, micro needle, micro pumps-continuous flow system, micro mixers		
UNIT V	APPLICATION OF BIO MEMS	9
CAD for MEMS, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA hybridization, Electronic nose, Bio chip.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to - CO1: Explain the design process of microsystems. - CO2: Demonstrate the mechanics involved in the design of sensors. - CO3: Explain about the electrostatic sensors and actuators. - CO4: Infer the concepts of microfluidic systems. - CO5: Apply the knowledge of CAD tools for MEMS design.		
TEXT BOOKS: 1. Chang Liu, “ Foundations of MEMS”, Pearson Education International, New Jersey, USA, 2006.		

2. Ellis Meng , “Biomedical Microsystems”, CRC Press, Boca Raton, FL, 2011.
3. Marc J. Madou,” Fundamentals of Microfabrication: the science of miniaturization”, CRC Press, 2002.

REFERENCES:

1. Nitaigour Premchand Mahalik, “MEMS”, Tata McGraw Hill Publishing Company, New Delhi, 2007.
2. Nadim Maluf, Kirt Williams. “An introduction to Micro electro mechanical Systems Engineering”, Second Edition, Artech House Inc, MA, 2004.
3. Tai Ran Hsu, ”MEMS and Microsystems design and manufacture”, Tata McGraw Hill Publishing Company, New Delhi, 2002.
4. Wanjun Wang, Steven A.Soper , ”BioMEMS- Technologies and applications”, CRC Press, BocaRaton, 2007.
5. Yang, Victor C., Ngo, That T,” Biosensors and Their Applications”, Springer, 2000.

VERTICAL IV

EMBEDDED SYSTEMS AND IOT

21PEC22	WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To know the fundamentals of wireless sensor networks. • To explain various MAC protocols. • To illustrate different data centric and energy aware routing protocols. • To explore about various operating systems used in sensor network architecture. • To summarize important applications of WSN.					
UNIT I	CHARACTERISTICS OF WSN	9			
Characteristic requirements for WSN ,Challenges for WSNs , WSN vs Adhoc Networks , Sensor node architecture , Commercially available sensor nodes , Imote , IRIS, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations					
UNIT II	MEDIUM ACCESS CONTROL PROTOCOLS	9			
Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts,Contention based protocols , Schedule-based protocols , SMAC ,BMAC , Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.					
UNIT III	ROUTING AND DATA GATHERING PROTOCOLS	9			
Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR, Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GPSR – Real Time routing Protocols – TEEN, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques					
UNIT IV	NETWORK OPERATING SYSTEMS DESIGN	9			

Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS –MANTIS. Introduction to TinyOS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.		
UNIT V	APPLICATIONS OF WSN	9
WSN Applications - Home Control – Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Infer the basics of Wireless Sensor Networks. CO2: Interpret the concepts of MAC Protocol. CO3: Illustrate various routing protocols. CO4: Summarize various operating systems for wireless sensor networks. CO5: Outline various applications of wireless sensor networks.		
TEXT BOOKS: 1. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education, 2008. 2. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003. 3. WaltenegusDargie , Christian Poellabauer, “Fundamentals of Wireless Sensor Networks - Theoryand Practice”, John Wiley & Sons Publications, 2011.		
REFERENCES: 1. Feng Zhao and LeonidesGuibas, "Wireless sensor networks ", Elsevier publication, 2004. 2. Jochen Schiller, "Mobile Communications", Pearson Education, 2 nd Edition, 2003. 3. William Stallings, "Wireless Communications and Networks ", Pearson Education, 2004. 4. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", JohnWiley, 2005. 5. Feng Zhao & Leonidas J.Guibas, “Wireless Sensor Networks- An Information		

Processing Approach", Elsevier, 2007.

6. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks-Technology, Protocols, and Applications", John Wiley, 2007.

21PEC23	MEMS DESIGN	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To relate the concept of MEMS technology and the materials used. • To infer fabrication methods used in MEMS technology. • To analyze the design of passive components using MEMS. • To gain knowledge on the design of new MEMS devices based on various principles. • To demonstrate the concept of nano electronics.					
UNIT I	OVERVIEW OF MICROSYSTEMS				12
MEMS and microsystems – typical products – Micro systems & miniaturization – principle of micro sensors- Bio medical and Bio sensors, chemical sensors, optical sensors – principle of micro actuation-thermal effects, shape memory alloy, piezo electric crystals, electro static force - MEMS with micro actuators – micro grippers.					
UNIT II	MATERIALS AND FABRICATION				12
Materials for MEMS and Micro system-Substrate and wafers - active substrate materials - silicon as substrate material-silicon compound - silicon piezo-resistors - Gallium arsenide – Quartz - Piezo electric crystals –Polymers Fabrication processes – photolithography - ion implantation – oxidation – Chemical vapour deposition– Physical vapour deposition – Etching - LIGA process.					
UNIT III	SENSORS AND SWITCHES				12
Case studies – capacitive accelerometer - Piezo electric pressure sensor - thermal sensor - radiation sensors - mechanical sensors - bio-chemical sensors - RF MEMS switch – Mechanical switch - Electronic Switch - Optical MEMS - Digital Micro Mirror device.					

UNIT IV	CASE STUDIES	12
Acceleration sensors - gyroscopes-piezo-resistive sensors-magnetic actuation-micro fluids applications-medical applications- optical MEMS.		
UNIT V	NANO ELECTRONICS	12
Nano electronics with tunneling devices – Nano electronics with super conducting devices - Molecular nano technology – Applications of MNT - Direct self-assembly- Electrostatic self-assembly-nano tubes – Nano wire and carbon-60 – Dielectrophoretic nano assembly.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to CO 1: Summarize about various MEMS devices. CO 2: Apply their knowledge for fabrication of MEMS materials. CO 3: Explicate the design of new MEMS devices based on various principles. CO4: Illustrate the case studies of application specific MEMS. CO5: Illustrate the principles of nano electronics with its applications.		
TEXTBOOKS: 1. Tai- Ran Hsu, “MEMS and Microsystems Design and Manufacture”, 1 st Edition, Tata McGraw Hill, 2017. 2. Nitaigour Mahalik, “MEMS”, 3 rd Edition, Tata McGraw Hill, 2014. 3. Paolo Di Barba, Slawomir Wiak, “MEMS: Field Models and Optimal Design”, Springer, 2019.		
REFERENCES: 1. Siva Yellampalli, “MEMS Sensors - Design and Application”, IntechOpen, 2018. 2. Rai Chaoudhary, “MEMS and MOEMS Technology and Applications”, 2 nd Edition, PHI Learning, 2012. 3. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, 2011. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures”, CRC Press, 2002.		

21PEC24	EMBEDDED AND REAL TIME SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To learn the architecture and programming of ARM processor. • To summarize the embedded computing platform design and analysis. • To expose the concepts and overview of real time operating system. • To explain the system design techniques and networks for embedded systems to industrial applications. • To demonstrate the applications of embedded systems in various domains.					
UNIT I	INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS	9			
Introduction to embedded computing: Characteristics of embedded computing applications, Challenges in embedded system design, Embedded system Design process. ARM 7(LPC2148) Processor Instruction set-Programming – GPIO configuration, UART, Interfacing of ADC and DAC.					
UNIT II	EMBEDDED COMPUTING PLATFORM DESIGN	9			
The CPU Bus–Memory devices and I/O devices–Models of programs– Assembly, linking and loading – compilation techniques– Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size– Program validation and testing.					
UNIT III	PROCESSES AND OPERATING SYSTEMS	9			
Introduction – Kernel, Threads –Multiple tasks and multiple processes – Multirate systems– Preemptive real–time operating systems– Priority based scheduling– Inter-process communication mechanisms. Introduction to OS- GPOS versus RTOS- Classification of RTOS- Example Real time operating systems– POSIX/Windows CE. Evaluating operating system performance.					
UNIT IV	SYSTEM DESIGN TECHNIQUES AND NETWORKS	9			
Design methodologies– Design flows – Requirement Analysis – Specifications – Quality Assurance techniques– Distributed embedded systems – Networks for embedded systems: I2C, Ethernet, Field bus– Overview on Internet of Things.					

UNIT V	APPLICATIONS OF EMBEDDED SYSTEMS	9
GPS Navigation system – Engine control unit – Audio Player– Video Accelerator – Digital Camera –Smart Home Security System – Challenges and trends in embedded systems in industrial applications.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Describe the architecture and programming of ARM processor. CO2: Outline the concepts of embedded systems. CO3: Illustrate the Multi rate task in real time operating system. CO4: Demonstrate the system design techniques for embedded systems. CO5: Model real-time consumer/industrial applications using embedded-system concepts.		
TEXT BOOKS: 1. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, 4 th Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2016. 2. Jane W.S.Liu , “Real Time Systems”, 3 rd Edition, Pearson Education, 2003. 3. Sriram V Iyer and Pankaj Gupta, “Embedded Real Time Systems Programming”, 1 st Edition, Tata McGraw Hill, 2017.		
REFERENCES: 1. Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, 3 rd Edition Cengage Learning, 2012. 2. David. E. Simon, “An Embedded Software Primer”, 1st Edition, Impression Addison Wesley Professional, 2007. 3. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, 1 st Edition, Tata McGraw-Hill Education, 2010. 4. K.V.K.K. Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, 1 st Edition, Dream Tech Press, 2005. 5. Sriram V Iyer and Pankaj Gupta, “Embedded Real Time Systems Programming”, 1 st Edition, Tata McGraw Hill, 2017. 6. Dr.Mark fisher ,”ARM Cortex M4 Cookbook”, 1 st Edition, PACKT publications, 2016.		

21PEC25	IOT BASED SYSTEM DESIGN	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: - To develop the programming skills for low power sensing applications using MSP430 Microcontroller. - To explain the advanced ARM Cortex microcontrollers. - To impart the knowledge of various peripherals related to sensing and communication. - To build IoT systems and sensor interfacing. - To design embedded systems for industrial applications.					
UNIT I	MSP430 MICROCONTROLLERS				12
Architecture of the MSP430, Memory, Addressing modes, Reflections on the CPU instruction set. Clock system, Exceptions: Interrupts and resets. Functions and subroutines, Mixing C and assembly language, Interrupts, Interrupt service routines, Issues associated with interrupts, Low power modes of operation.					
UNIT II	ARM CORTEX MX MICROCONTROLLER				12
ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations, Advanced Cortex MX Microcontroller, core, architecture, on-chip Wi-Fi.					
UNIT III	DISPLAY AND COMMUNICATION MODULES AND SENSORS INTERFACING				12
GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbee controller. Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11, single wire thermometer, Frequency counters.					
UNIT IV	MICROCONTROLLERS PLATFORM FOR IOT				12
ESP8266, NodeMCU, TI-CC3200,Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Gallileo boards.					
UNIT V	SINGLE BOARD COMPUTERS AND CLOUD INTERFACING				12
Raspberry pi board, porting Raspbian, sensor interface examples, Python programming for					

cloud access, sensor systems using Arduino boards, Interfacing and data logging with cloud: Thing speak, Things board, Blync platform.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of this course, learners will be able to

CO1: Design embedded programs for sensor applications.

CO2: Develop ARM basic and advanced programs.

CO3: Interface and deploy analog and digital sensors.

CO4: Develop communication system with sensor units.

CO5: Design IoT systems using Wi-Fi CC3200 and program the single board computers.

TEXT BOOKS:

1. John H. Davies, "MSP430 Microcontroller Basics", 2nd Edition, Newnes publishing, New York, 2011.
2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 4th Edition, Springer, New York, 2014.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, USA, 2017.

REFERENCES:

1. Sergey Y. Yurish, "Digital Sensors and Sensor Systems: Practical Design", 1st Edition, IFSA publishing, New York, 2011.
2. Jonathan W Valvano, "Introduction to ARM Cortex – M3 Microcontrollers", 5th Edition., Create Space publishing, New York, 2012.
3. Muhammad Ali Mazidi, Shujen Chen, Sarmad Naimi and Sepehr Naimi, "TI ARM Peripherals Programming and Interfacing: Using C Language", 2nd Edition, Mazidi and Naimi publishing, New York, 2015.

21PEC26	CONTROL SYSTEMS FOR IOT APPLICATIONS	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: To impart the knowledge of the components and their representation of control					

systems. • To outline the methods for analyzing the time response and stability of the systems. • To gain knowledge about various methods for analyzing the frequency response and stability of the systems. • To explain the working of sensors and actuators. • To analyze the control theory as used in embedded systems and IoT platforms.		
UNIT I	SYSTEMS COMPONENTS AND THEIR REPRESENTATION	12
Control System: Terminology and Basic Structure-Feed forward and Feedback control theory, Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system		
UNIT II	TIME RESPONSE ANALYSIS	12
Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI,PID control systems		
UNIT III	FREQUENCY RESPONSE AND SYSTEM ANALYSIS	12
Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot – Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation.		
UNIT IV	SENSORS AND ACTUATORS	12
Linear and angular displacement sensors: resistance sensor, induction displacement sensor, digital optical displacement sensor, pneumatic sensors. Speed and flow rate sensors, Force sensors. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.		
UNIT V	CASE STUDIES/INDUSTRIAL APPLICATIONS	12
Cisco IoT system, IBM Watson IoT platform, Manufacturing, Converged Plant wide Ethernet Model (CPwE), Power Utility Industry, Grid Blocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.		

TOTAL: 60 PERIODS	
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Demonstrate the various control system components and their representations. CO2: Analyze the various time domain parameters. CO3: Analyze the various frequency response plots and its system. CO4: Outline the Sensors and Actuators used in control systems. CO5: Summarize applications of IoT in real time scenario.	
TEXT BOOKS: 1. M.Gopal, “Control System – Principles and Design”, 4 th Edition, Tata McGraw Hill, 2012. 2. TimWiscott, “Applied control for embedded systems”, 1 st Edition, Elsevier Publications, 2006. 3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, 1 st Edition, Cisco Press, 2017.	
REFERENCES: 1. J.Nagrath and M.Gopal, “Control System Engineering”, 5 th Edition, New Age International Publishers, 2007. 2. K. Ogata, “Modern Control Engineering”, 5 th edition, PHI, 2012. 3. S.K.Bhattacharya, Control System Engineering, Pearson, 3 rd Edition, 2013.	

21PEC27	INDUSTRIAL IOT AND INDUSTRY 4.0	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To explore the Industrial Internet of Things. - To illustrate the cyber system and Big Data Analytics. - To outline various IIoT Architectures and domains. - To explain Communication Protocols used in IIoT.					

To summarize the business issues in Industry 4.0.		
UNIT I	INTRODUCTION TO INDUSTRIAL INTERNET	9
Innovation and IIoT, Intelligent Devices, Industrial Internet, Health care, Oil and Gas Industry, Smart Office, Logistics, IoT Innovations in Retail.		
UNIT II	INDUSTRY 4.0	9
Miniaturization – Cyber Physical Systems – Wireless technology – IP Mobility – Network Functionality Virtualization – Cloud and Fog - Big Data and Analytics – M2M Learning and Artificial Intelligence.		
UNIT III	IIOT REFERENCE ARCHITECTURE	9
Industrial Internet Architecture Framework – Functional Viewpoint – Operational Domain, Information Domain, Application Domain, Business Domain – Implementation View point – Architectural Topology – Three Tier Topology – Data Management.		
UNIT IV	INDUSTRIAL INTERNET SYSTEMS	9
Introduction-Proximity Network Protocols – WSN Edge Node – Legacy Industrial Protocols – RS232 Serial Communications, 40-20ma Current Loop, Field Bus Technologies – Modern Communication Protocols – Industrial Ethernet – Industrial Gateways.		
UNIT V	BUSINESS ISSUES IN INDUSTRY 4.0	9
Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Classify the Industrial Internet of Things. CO2: Illustrate the cyber system and Big Data Analytics. CO3: Outline various IIoT Architecture and domains. CO4: Interpret Communication Protocols used in IIoT. CO5: Summarize the Business Issues in Industry 4.0.		
TEXT BOOKS: 1. S. Misra, A. Mukherjee and A. Roy, “Introduction to IoT”, 1 st Edition, Cambridge		

University Press, 2020.
2. S. Misra, C. Roy and A. Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0.”, 1 st Edition, CRC Press. 2020.
3. Dr. Guillaume Girardin, Antoine Bonnabel and Eric Mounier, "Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024",Yole Development Copyrights, 2014.
REFERENCES:
1. Jean-Claude André “Industry 4.0”, Wiley- ISTE, 2019.
2. Miller M, “The internet of things: How smart TVs, smart cars, smart homes, and smart cities are changing the world”, 1st Edition, Pearson Education, 2015.
3. Diego Galar Pascual, Pasquale Daponte and Uday Kumar, “Handbook of Industry 4.0 and SMART Systems”, 1 st Edition, Taylor and Francis, 2020

21PEC28	IOT FOR SMART SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
• To explain Internet of Things technologies and its role in real time applications. • To infer the infrastructure required for IoT. • To gain knowledge about the accessories and communication techniques for IoT. • To provide insight about the embedded processor and sensors required for IoT. • To learn about the different platforms and Attributes for IoT.					
UNIT I	INTRODUCTION TO INTERNET OF THINGS				9
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.					
UNIT II	IOT ARCHITECTURE				9
IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.					
UNIT III	PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT				9
NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA,					

LTE, GPRS, small cell. Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee, Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.		
UNIT IV	IOT PROCESSORS	9
Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.		
UNIT V	CASE STUDIES	9
Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Analyze the concepts of IoT and its present developments. CO2: Compare different platforms and infrastructures available for IoT. CO3: Explain different protocols and communication technologies used in IoT. CO4: Analyze the big data analytic and programming of IoT. CO5: Implement IoT solutions for smart applications.		
TEXT BOOKS: 1. Arshdeep Bahga and Vijai Madisetti : A Hands-on Approach “Internet of Things”, Universities, Press 2015. 2. Oliver Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things”, Wiley,2016. 3. Samuel Greengard, “The Internet of Things”, The MIT press, 2015.		
REFERENCES: 1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things “, Wiley, 2014. 2. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010. 3. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.		

VERTICAL V

SPACE TECHNOLOGIES

21PEC29	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the basics of satellite orbits and launching procedures. • To illustrate the satellite segment and earth segment. • To understand various parameters involved in designing satellite link. • To analyze the various methods of satellite access. • To interpret the applications of satellite systems.					
UNIT I	SATELLITE ORBITS	9			
Frequency allocations for satellite services, Kepler’s Laws, Newton’s law, orbital parameters, orbital perturbations, Station keeping, Geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility – eclipse -Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.					
UNIT II	SPACE SEGMENT AND EARTH SEGMENT	9			
Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, Communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders - Antenna subsystem. Earth Segment - TVRO, MATV, CATV, Transmit and Receive earth station.					
UNIT III	SATELLITE LINK DESIGN	9			
EIRP, Transmission losses, Link budget equation, Performance impairments - System noise, Rain induced attenuation, Ionospheric characteristics, Inter modulation and interference, C/N ratio - Uplink and downlink analysis and design, Rain fade margin, Combined Uplink and Downlink C/N Ratio.					
UNIT IV	SATELLITE ACCESS AND CODING METHODS	9			
Modulation and Multiplexing - Voice, Data, Video, Analog and digital transmission system,					

Digital video Broadcast, Satellite access - Preassigned and demand assigned FDMA, TDMA - CDMA, Compression – Encryption, Coding Schemes.		
UNIT V	SATELLITE APPLICATIONS	9
INTELSAT Series, INSAT, VSAT, Mobile satellite services - GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast Satellites (DBS/DTH).		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners should be able to CO1: Summarize the basics of satellite orbits and launching procedures. CO2: Illustrate the components of Space Segment and Earth Segment. CO3: Outline the uplink and downlink analysis of satellite. CO4: Compare multiple access schemes in satellite systems. CO5: Summarize the applications of satellite systems.		
TEXT BOOKS: 1. Dennis Roddy, “Satellite Communication”, 4 th Edition, Mc Graw Hill International, 2017. 2. Timothy Pratt, Charles, Bostain, Jeremy E.Allnutt,"Satellite Communication”, 3 rd Edition, Wiley Publications, 2019. 3. Bruce R. Elbert, “The Satellite Communication Applications Hand Book”, 2 nd Edition, Artech House Boston London, 2004.		
REFERENCES: 1. Wilbur L.Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, “Satellite Communication Systems Engineering”, 2 nd Edition, Prentice Hall/Pearson, 2007. 2. N.Agarwal, “Design of Geosynchronous Space Craft”, 1 st Edition, Prentice Hall, 1986. 3. Tri T. Ha, “Digital Satellite Communication”, 2 nd Edition, TMH, 1990.		

21PEC30	AVIONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:		
• To illustrate the basics of avionics and its need for civil and military aircrafts. • To summarize the various architectures of avionics. • To explain the various control and display technologies. • To outline the various avionics navigation subsystems. • To construct an autopilot system for aircrafts using MATLAB.		
UNIT I	INTRODUCTION TO AVIONICS	9
Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems, design, technologies – Introduction to digital computer and memories.		
UNIT II	ARCHITECTURE OF DIGITAL AVIONICS	9
Avionics system architecture – Data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.		
UNIT III	FLIGHT DECKS AND COCKPITS	9
Control and display technologies: CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI), Virtual Cockpit - Civil and Military Cockpits. MFDS, HUD, MFK, HOTAS.		
UNIT IV	INTRODUCTION TO NAVIGATION SYSTEMS	9
Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS, Inertial Navigation Systems (INS): Inertial sensors, 3D gyro - INS block diagram – Satellite navigation systems – GPS – Unmanned aerial vehicle system – Design methodology.		
UNIT V	AIR DATA SYSTEMS AND AUTO PILOT	9
Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:

At the end of the course, the learners will be able to

- CO1: Summarize the technologies of avionics systems and its sub systems.
- CO2: Compare the various architecture and functionalities of digital avionics.
- CO3: Outline the various display and control technologies of decks and cockpit.
- CO4: Interpret the design of navigation systems.
- CO5: Develop an autopilot systems for small aircrafts using MATLAB.

TEXTBOOKS:

1. Albert Helfrick. D., "Principles of Avionics", 9th Edition, Avionics Communications Inc., 2015.
2. Collinson. R.P.G. "Introduction to Avionics", 3rd Edition, Chapman and Hall, 2014.
3. Scott Kenney, "Avionics-Fundamentals of Aircraft Electronics", Avotek Information Resources, 2013

REFERENCES:

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", 1st Edition, Longman Group UK Ltd., England, 2007.
2. Spitzer, C.R. "Digital Avionics Systems", 2nd Edition, Prentice-Hall, Englewood Cliffs, 2001.
3. Spitzer. C.R. "The Avionics Hand Book", 3rd Edition, CRC Press, 2017.

21PEC31	POSITIONING AND NAVIGATION SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To know about the elements of satellite orbits. • To infer various electronic observation techniques. • To impart knowledge about the operation of GPS receivers. • To explain various GPS data processing techniques. • To gain knowledge on various applications of satellite geodesy.					
UNIT I	BASICS OF ORBITAL MECHANICS	9			

Definition – Fundamental goals of Geodesy – Definitions – basic concepts – Historical perspective – development applications in Satellite Geodesy – Geoid and Ellipsoid satellite orbital motion – Keplerian motion – Kepler’s Law – Perturbing forces – Geodetic satellite.		
UNIT II	EARTH OBSERVATION TECHNIQUES	9
Determination of direction by photography – SECOR – Electronic observation techniques – Doppler effect – Positioning concept – Development of TRANSIT satellites.		
UNIT III	SATELLITE SYSTEM	9
GPS – Different segments – space control and user segments – satellite configuration – GPS signal structure – Orbit determination and Orbit representation Anti Spoofing and Selective Availability – Task of control segment – GPS receivers – main receiver components – Example of GPS receivers.		
UNIT IV	GPS DATA PROCESSING	9
GPS observables – code and carrier phase observation – linear combination and derived observables – concept of parameter estimation – data processing – software modules – solutions of cycle slips ambiguities RINEX format. Concepts of rapid static methods with GPS semi kinematic and pure kinematic methods – basic constellation of satellite geometry & accuracy measures.		
UNIT V	APPLICATIONS OF SATELLITE GEODESY	9
Geodetic control surveys, Cadastral surveying, Photogrammetry & Remote Sensing, Engineering applications, and Monitoring – GIS. GLONASS, GALILEO, COMPASS and IRNSS satellite configuration comparison – Satellite Laser Ranging & Applications – Concepts of satellite altimetry.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Outline the elements of satellite orbits. CO2: Explain the techniques of development of satellites. CO3: Infer the working of GPS receivers. CO4: Demonstrate the error detection and correction methods of GPS data. CO5: Illustrate the applications of Satellite Geodesy.		

TEXT BOOKS:

1. Gunter Seeber, Walter De Gruyter, “Satellite Geodesy”, 1st Edition, Prentice Hall, 2003.
2. W. B, Lichtenegger. H, Collins. J, “Global Positioning System – Theory and Practice – Hofmann”, 1st Edition, Springer Verlag Wein, New York, 2008.
3. Alfred Leick, “GPS Satellite Surveying”, 3rd Edition, John Wiley and Sons, 2004.

REFERENCES:

1. G. S. Rao, “Global Navigation Satellite Systems”, 1st Edition, Tata McGraw Hill Education Pvt. Ltd, 2002.
2. Guocheng Xu, “GPS Theory, Algorithms and Applications”, 1st Edition Springer-Verlag, 2003.
3. Parkinson, B. W., J. Spilker, et al. Global Positioning System: Theory and Applications. Vol. 1. American Institute of Aeronautics & Ast, 2001

21PEC32	RADAR TECHNOLOGIES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the fundamentals concepts of radar systems. • To summarize the basics of signal models. • To illustrate the concepts of sampling and quantization of pulsed radar signals. • To provide in-depth knowledge in radar waveforms. • To gain knowledge on Doppler processing techniques.					
UNIT I	INTRODUCTION TO RADAR SYSTEMS	9			
Basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing.					
UNIT II	SIGNAL MODELS	9			
Components of a radar signal, amplitude models, types of clutters, noise model and signal-to-noise ratio, jamming, frequency models: the Doppler shift, spatial models, spectral model.					

UNIT III	SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS	9
Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the Doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.		
UNIT IV	RADAR WAVEFORMS	9
Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range side lobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency codes.		
UNIT V	DOPPLER PROCESSING	9
Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Infer the fundamental concepts behind radar systems. CO2: Outline various signal models involved in radar systems. CO3: Demonstrate the sampling and quantization techniques of pulsed radar signals CO4: Illustrate different types of radar waveforms. CO5: Summarize the Doppler processing issues.		
TEXT BOOKS: 1. Mark A. Richards, “Fundamentals of Radar Signal Processing”, 1st Edition, McGraw-Hill, New York, 2005 2. Francois Le Chevalier, “Principles of Radar and Sonar Signal Processing”, 1st Edition Artech House, 2002. 3. Michael O Kolawole, “Radar systems, Peak Detection and Tracking”, 1st Edition, Elsevier, 2010.		
REFERENCES: 1. Skolnik, “Introduction to Radar Systems” 3rd Edition, McGraw Hill, 2003.		

2. Peyton Z. Peebles, “Radar Principles”, 1st Edition, Wiley India, 2009
3. Fred E. Nathanson, “Radar Design Principles-Signal Processing and the Environment”, PHI, 1999.

21PEC33	REMOTE SENSING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the basic principles of remote sensing. • To acquire knowledge about the motion of satellites in the space. • To expose the various types of sensors used for remote sensing. • To gain knowledge about the generation of satellite data products. • To explain various stages of satellite image analysis.					
UNIT I	PHYSICS OF REMOTE SENSING	9			
Remote Sensing - Definition - Components - Electro Magnetic Spectrum – Basic wave theory – Particle theory – Stefan Boltzman law - Wiens-Displacement Law - Radiometric quantities - Effects of Atmosphere- Scattering – Different types –Absorption-Atmospheric window- Energy interaction with surface features – Spectral reflectance of vegetation, soil and water – atmospheric influence on spectral response patterns- multi concept in Remote sensing.					
UNIT II	PLATFORMS	9			
Orbit elements – Types of orbits – Motions of planets and satellites – Launch of space vehicle – Orbit perturbations and maneuvers – escape velocity - Types and characteristics of different remote sensing platforms – sun synchronous and geo synchronous satellites.					
UNIT III	SENSORS	9			
Classification of remote sensors – selection of sensor parameters - resolution concept - Spectral, Radiometric and temporal resolution – Quality of images – imaging mode – photographic camera – opto-mechanical scanners – pushbroom and whiskbroom cameras – Panchromatic, multi spectral ,thermal, hyperspectral scanners and microwave sensors – geometric characteristics of scanner imagery – Operational Earth resource satellites - Landsat, SPOT, IRS, WorldView, hyperion and hysis, ERS, ENVISAT, Sentinel.					

UNIT IV	DATA RECEPTION AND DATA PRODUCTS	9
Ground segment organization – Data product generation – sources of errors in received data – referencing scheme – data product output medium – Digital products – Super structure, Fast, GeoTIFF, Hierarchical and HDF formats – Indian and International Satellite Data Products – ordering of data		
UNIT V	DATA ANALYSIS	9
Data products and their characteristics – Elements of visual interpretation – interpretation keys – Digital image processing – Preprocessing – Image rectification – Image enhancement techniques– Image classification – Supervised and unsupervised classification algorithms for multispectral and hyperspectral images – Accuracy assessment.- hybrid classification techniques – Knowledge based classification, Neural Network Classification, Fuzzy Classification.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Summarize the concepts and laws related to remote sensing. CO2: Illustrate various remote sensing platforms. CO3: Explain the characteristics of different types of remote sensors. CO4: Outline the concepts of data reception, product generation, storage and ordering of satellite data. CO5: Illustrate different image processing techniques and interpretation of satellite data.		
TEXT BOOKS: 1. Lillesand T.M. and Kiefer. “R.W. Remote Sensing and Image Interpretation”, 4 th Edition, John Wiley and Sons, 2015. 2. John R. Jensen, “Introductory Digital Image Processing: A Remote Sensing Perspective”, 4 th Edition, Pearson Education, 2015. 3. Campbell, J.B, “ Introduction to Remote Sensing”, Taylor Publications,2002.		
REFERENCES: 1. John A.Richards, “Remote Sensing Digital Image Analysis”, 5 th Edition, Springer – Verlag, 2013. 2. George Joseph, “Fundamentals of Remote Sensing”, 3 rd Edition, Universities Press Pvt. Ltd, Hyderabad, 2018.		

3. Joseph George,” Fundamentals of Remote Sensing”, Universities Press, 2003.

21PEC34	UNMANNED AERIAL VEHICLES AND DRONES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the basics of UAV and its applications. • To design an UAV system with aerodynamic concepts. • To explain the suitable avionics hardware for UAV system. • To summarize the payloads and control devices. • To develop and simulate the UAV system with ground control station.					
UNIT I	INTRODUCTION TO UAV				9
History of UAV: classification, Introduction to Unmanned Aircraft Systems: models and prototypes, System Composition, applications.					
UNIT II	DESIGN OF UAV SYSTEMS				9
Introduction to Design and Selection of the System: Aerodynamics and Airframe Configurations, Vehicle drag, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects: UK,USA and Europe, Design for Stealth: Control surfaces, Specifications.					
UNIT III	AVIONICS HARDWARES				9
Autopilot: AGL, Pressure sensors, Servos, Accelerometer, Gyros, Actuators, Air frame controller, Power supply, Processor, Integration, Installation, Configuration and Testing.					
UNIT IV	COMMUNICATION PAYLOADS AND CONTROLS				9
Payloads: Telemetry, Tracking, Aerial photography, Controls: PID feedback, Radio control frequency range, Modems, Memory system, Simulation: Ground test, Analysis, Trouble shooting.					
UNIT V	THE DEVELOPMENT OF UAV SYSTEMS				9

Waypoints navigation: Ground control software: System Ground Testing, System In-flight Testing, Future Prospects and Challenges: Case Studies, Mini and Micro UAVs, Ornithopter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the learners will be able to

- CO1: Explain the basics of unmanned systems and its applications.
- CO2: Apply the aerodynamics and airframe configurations for UAV design.
- CO3: Make use of suitable avionics hardware for autopilot system.
- CO4: Outline the various payloads and control devices of UAV.
- CO5: Build an UAV system with ground control and waypoint navigation

TEXT BOOKS:

1. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, 5th Edition, Wiley publications, 2022.
2. Reg Austin, “Unmanned Aircraft Systems: UAVs design, development and deployment”, 1st Edition, Wiley, 2011.
3. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones”, Maker Media, Inc, 2016.

REFERENCES:

1. Dr. Armand J. Chaput, Design of Unmanned Air Vehicle Systems, 1st Edition, Lockheed Martin Aeronautics Company, 2001.
2. Kimon P. Valavanis, Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Springer, 2008.
3. Robert C. Nelson, Flight Stability and Automatic Control, 4th Edition, McGraw-Hill, Inc, 2000.

21PEC35	ROCKETRY AND SPACE MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: • To infer the advanced concepts in Rocketry and Space Mechanics • To apply the necessary mathematical knowledge in understanding the physical process • To explain the concepts of Orbital Mechanics and Rocket Propulsion • To develop the rocketry systems using and Aerodynamics and Rocket Staging • To understand the concepts of understanding of Rockets and like spacecraft systems.		
UNIT I	ORBITAL MECHANICS	9
Description of solar system – Kepler’s Laws of planetary motion – Newton’s Law of Universal gravitation – Two body and Three-body problems – Jacobi’s Integral, lunar and deep space missions, Librations points - Estimation of orbital and escape velocities.		
UNIT II	SATELLITE DYNAMICS	9
Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – methods to calculate perturbations- Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements.		
UNIT III	ROCKET MOTION	9
Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity- dispersion of finned rockets – Stability of flight.		
UNIT IV	ROCKET AERODYNAMICS	9
Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – Nozzle Configurations; Real Nozzles– rocket dispersion – launching problems.		
UNIT V	STAGING AND CONTROL OF ROCKET VEHICLES	9
Need for multistaging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.		
TOTAL : 45 PERIODS		

COURSE OUTCOMES:

At the end of this course, learners will be able to

- CO1: Make use of the basic concepts of orbit mechanics to estimate the orbital parameters.
- CO2: Apply the methods to calculate the satellite coordinates from orbital elements.
- CO3: Illustrate the motion of rocket with metrics.
- CO4: Explain the rocket motion by considering the aerodynamics.
- CO5: Summarize the different staging and control of the rocket vehicles.

TEXT BOOKS:

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982
3. Craig A. Kluever, "Space Flight Dynamics", 1st Edition, Wiley, 2018.

REFERENCES:

1. Van de Kamp, "Elements of astromechanics", Pitman Publishing Co., Ltd., London, 1980.
2. E.R. Parker, "Materials for Missiles and Spacecraft", McGraw-Hill Book Co., Inc., 1982.
3. Turner, M. J. L. "Rocket and Spacecraft Propulsion: Principle, Practice and New Developments", Springer Verlag. 2000.

VERTICAL VI**HIGH SPEED COMMUNICATIONS**

21PEC36	WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To summarize the importance of improving capacity of wireless channel using MIMO. • To illustrate the propagation of radio wave and fading measurements. • To outline the channel impairment mitigation using space-time block codes.					

- To interpret the channel impairment mitigation using space-time Trellis codes. - To explore advanced MIMO system.		
UNIT I	CAPACITY OF WIRELESS CHANNELS	9
The crowded spectrum, Need for high data rate, MIMO systems – Array Gain, Diversity Gain, Data Pipes, Spatial multiplexing, MIMO System Model. MIMO System Capacity – Channel known at the transmitter, Channel unknown to the transmitter – Capacity of deterministic channels, Random channels and frequency selective channels.		
UNIT II	RADIO WAVE PROPAGATION	9
Radio wave propagation – Macroscopic fading - Free space and outdoor, small scale fading, Fading measurements – Direct pulse measurements, spread spectrum correlation channel sounding, frequency domain channel sounding, Antenna Diversity – Diversity combining methods.		
UNIT III	SPACE TIME BLOCK CODES	9
Delay diversity scheme, Alamouti space time code – Maximum likelihood decoding, Ratio combining. Transmit diversity, Space time block codes for real signal constellation and complex signal constellation - Decoding of STBC.		
UNIT IV	SPACE TIME TRELLIS CODES	9
Space time coded systems, space time code word design criteria, design of STTC on slow fading channels, design of STTC on Fast Fading channels, performance analysis in slow and fast fading channels, effect of imperfect channel estimation and antenna correlation on performance, comparison of STBC & STTC.		
UNIT V	LAYERED SPACE TIME CODES	9
LST transmitter – Horizontal and Vertical LST receiver – ML Receiver, Zero forcing Receiver; MMSE Receiver, SIC Receiver, ZF V-blast Receiver - MMSE V-blast Receiver, Iterative Receiver - Capacity of MIMO – OFDM systems – Capacity of MIMO multiuser systems.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Outline the importance of improving capacity of wireless channel using MIMO. CO2: Illustrate the propagation of radio wave and fading measurements.		

CO3: Interpret the channel impairment mitigation using space-time block codes.	
CO4: Summarize the channel impairment mitigation using space-time Trellis codes.	
CO5: Outline the advanced MIMO system & MIMO OFDM systems.	
TEXT BOOKS:	
1. Mohinder Jankiraman, “Space-time codes and MIMO systems”, 1st Edition, Artech House, Boston, London, 2004. 2. Paulraj Rohit Nabar, Dhananjay Gore, “Introduction of space time wireless communication systems”, 1st Edition, Cambridge University Press, 2003. 3. Andrea Goldsmith, “Wireless Communication”, 1st Edition, Cambridge University Press, 2011	
REFERENCES:	
1. David Tse and Pramod Viswanath, “Fundamentals of Wireless communication”, 1st Edition, Cambridge University Press, 2005. 2. Sergio Verdu, “Multiuser Detection”, 1st Edition, Cambridge University Press, 1998. 3. Van Nee, R. and Ramji Prasad, “OFDM for Wireless Multimedia Communications”, 1st Edition, Artech House, 2000.	

21PEC37	WIRELESS BROADBAND NETWORKS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To infer about various networking service aspects of broadband networks. • To interpret the wireless protocols associated with different layers. • To explain the significance of LTE and 4G standards • To summarize the specification and challenges of LTE-A standard. • To explore the concepts of 5G services.					
UNIT I	EVOLUTION OF WIRELESS NETWORKS	9			
Evolution of Broadband Wireless; Fixed Broadband Wireless and Mobile Broadband Wireless; WiMAX, 3G & Wi-Fi Systems; Spectrum Options for Broadband Wireless; Technical					

Challenges for Broadband Wireless - Spectrum Scarcity, Quality of Service, Mobility, Portability, Security, Supporting IP in Wireless. Review of cellular standards, migration and advancement of GSM architecture and CDMA architecture, WLAN – IEEE 802.11 and HIPERLAN, Bluetooth.		
UNIT II	WIRELESS PROTOCOLS	9
Mobile network layer: Fundamentals of Mobile IP, data forwarding procedures in mobile IP, IPv4, IPv6, IP mobility management, IP addressing, DHCP, Mobile transport layer, Internet protocol (IP), TCP/IP, Bluetooth low energy, ZigBee, 6 LoWPAN, Wi-Fi: 802.11ax, 802.11ac, 802.11n.		
UNIT III	LTE AND EVOLUTION TO 4G	9
Overview of 3G and 3GPP. LTE System Overview, The Evolution from UMTS to LTE, Requirements and Targets for LTE; LTE Radio Access – Transmission Scheme, Spectrum Flexibility, Channel Dependent Scheduling and Rate Adaptation, Inter-Cell Interference Combining, Multi Antenna Transmission.; Technologies for LTE; Network Architecture – Overall Architecture Overview, Protocol Architecture.		
UNIT IV	4G AND BEYOND	9
Introduction to LTE-A – Requirements and Challenges, network architectures – EPC, UE Categories for LTE Advanced, E-UTRAN architecture - mobility management, resource management, services, channel - logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.		
UNIT V	5G TECHNOLOGIES	9
Introduction to 5G – Use Cases - 5G NR and 5G core network (5GCN) - Spectrum for 5G – 5G deployment - Options, Challenges and Applications. Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication - mmWave Communications - Massive MIMO networks.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to, - CO1: Summarize the significance of broadband services. - CO2: Explain the network and transport layer protocols in wireless LANs - CO3: Compare the operation of various cellular technologies		

CO4: Interpret the connection oriented services over 4G networks.
CO5: Outline the enabling technologies for 5G networks.
TEXT BOOKS: 1. Kaveh Pahlavan, “Principles of wireless networks”, 2nd Edition, Prentice-Hall of India, 2013. 2. Moray Rumney, “LTE and Evolution to 4G Wireless: Design and Measurement Challenges”, 2nd Edition, Agilent Technologies, 2013. 3. Saad Z. Asif, “5G Mobile Communications Concepts and Technologies”, 1st Edition, CRC Press, 2018.
REFERENCES: 1. Erik Dahlman, Stefan Parkvall, Johan Skold “5G NR: The Next Generation Wireless Access Technology”, 1st Edition, Academic Press, 2018. 2. Jonathan Rodriguez, “Fundamentals 5G Mobile Networks”, 1st Edition, John Wiley & Sons, 2015. 3. Luis .M, Correia, “Mobile Broadband Multimedia Networks: Techniques, Models and Tools for 4G”, Elseiver, 2010.

21PEC38	4G/5G COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3
OBJECTIVES: • To explore the network architecture in 4G wireless systems. • To analyze the issues in OFDM, SC – FDMA modulation schemes. • To provide adequate knowledge of transmit diversity • To explain the MIMO spatial Multiplexing. • To explore new technologies for 5G systems.					
UNIT I	4G NETWORK ARCHITECTURE AND OFDM	9			
LTE – Evolution to 4G – Network Architecture – Multicast System Architecture – OFDM – Mathematical system model for OFDM system – OFDM for downlink – Capacity of OFDMA					

–SNR Analysis of OFDM system – Walsh Spread OFDM – Fast Frequency Hopping OFDM		
UNIT II	PAPR PROBLEM IN OFDM AND SC– FDMA	9
Introduction to SC – FDMA – SCFDMA for uplink – Hybrid SCFDMA OFDM – PAPR problem in OFDM – Measure of PAPR – PAPR in QAM modulations – PAPR in SCFDMA – PAPR with spectrum shaping – Coverage gain.		
UNIT III	TRANSMIT DIVERSITY	9
Transmit Diversity Schemes – Cyclic Delay Diversity – Frequency Shift transmit diversity – time shift transmit diversity – Precoding vector switching – Block codes based transmit diversity – Downlink transmission chain – Codeword to layer Mapping – Transmit diversity precoding		
UNIT IV	SPATIAL MULTIPLEXING AND CHANNEL STRUCTURE	9
MIMO Spatial Multiplexing – MIMO capacity – Code words and Layer Mapping – Downlink MIMO transmission chain– MIMO Precoding – CDD based precoding – Open loop spatial multiplexing – Channel Structure and Bandwidth –Frame and Slot structure — Link adaptation and feedback computation.		
UNIT V	OVERVIEW OF NEW TECHNOLOGIES FOR 5G SYSTEMS	9
Introduction – Cloud Radio Access Networks – Cloud computing and Fog computing- Non-orthogonal Multiple Access- Flexible physical layer design-Massive MIMO-Full Duplex communication –Millimeter wave-IoT,M2M and D2D-Energy Harvesting communication-Visible Light Communication-Basics about RAN architecture.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: Upon completion of the course, the learners will be able to: - CO1: Explain the hardware requirements of transmitter and receiver for 4G wireless systems. - CO2: Evaluate OFDM and SCDMA based wireless system. - CO3: Evaluate Diversity and Spatial Multiplexing schemes in 4G wireless systems. - CO4: Interpret transceiver for 4G wireless systems specifications. - CO5: Infer the state-of-the-art research on 5G systems.		

TEXT BOOKS:

1. Stefania Sesia, Issam Toufik and Matthew Baker, “LTE – The UMTS Long Term Evolution: From Theory to Practice”, 2nd Edition, John Wiley & Sons, 2011.
2. Farooq Khan, “LTE for 4G Mobile Broadband Air Interface Technologies and Performance”, 1st Edition Cambridge University Press, 2009.
3. Vincent W. S. Wong, Robert Schober, Derrick Wing Kwan Ng, Li-Chun Wang, “Key Technologies for 5G Wireless Systems”, 1st Edition, Cambridge University Press, 2017.

REFERENCES:

1. Ralf Kreher and Karsten Gaenger, “LTE Signaling, Troubleshooting and Optimization”, 1st Edition, John Wiley & Sons, 2010.
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, 1st Edition, Cambridge University Press, 2016.
3. Anwer Al-Dulaimi, Chih-Lin I, Xianbin Wang, “5G Networks- Fundamental Requirements, Enabling Technologies, and Operations Management”, Wiley, USA, 2018.

21PEC39	COGNITIVE RADIO NETWORKS	L	T	P	C
		3	0	0	3
OBJECTIVES: • To explain the basics of SDR and Cognitive Radio. • To know the basics of various spectrum sensing techniques. • To recognize the concepts of cooperative spectrum sensing. • To outline the functions of MAC layer and Network layer. • To learn the basics of security management and the various attacks.					
UNIT I	INTRODUCTION TO COGNITIVE RADIO	9			
Introduction –Software Defined Radio: Architecture–Digital Signal Processor and SDR Baseband architecture – Reconfigurable Wireless Communication Systems – Digital Radio Processing –Cognitive Radio: Cognitive radio Framework – Functions – Paradigms of Cognitive Radio					

UNIT II	SPECTRUM SENSING	9
Introduction –Spectrum Sensing – Multiband Spectrum Sensing – Sensing Techniques – Other algorithms – Comparison – Performance Measure & Design Trade-Offs : Receiver operating characteristics – Throughput Performance measure –Fundamental limits and trade-offs		
UNIT III	COOPERATIVE SPECTRUM ACQUISITION	9
Basics of cooperative spectrum sensing–Examples of spectrum acquisition techniques – cooperative transmission techniques – sensing strategies– Acquisition in the Presence of Interference: Chase combining HARQ –Regenerative cooperative Diversity– spectrum overlay– spectrum handoff		
UNIT IV	MAC PROTOCOLS AND NETWORK LAYER DESIGN	9
Functionality of MAC protocol in spectrum access –classification –Interframe spacing and MAC challenges – QOS – Spectrum sharing in CRAHN –CRAHN models – CSMA/CA based MAC protocols for CRAHN – Routing in CRN– Centralized and Distributed protocols – Geographical Protocol.		
UNIT V	TRUSTED COGNITIVE RADIO NETWORKS	9
Trust for CRN :Fundamentals – Models – Effects of Trust Management –Security properties in CRN – Route Disruption attacks –Jamming attacks –PU Emulation attacks.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to: - CO1: Compare SDR and Cognitive radio. - CO2: Analyze the various spectrum sensing techniques. - CO3: Summarize the cooperative spectrum acquisition. - CO4: Interpret the concepts of MAC protocols and network layer. - CO5: Outline the various attacks in cognitive radio networks.		
TEXT BOOKS 1. Mohamed Ibnkahla, “Cooperative Cognitive Radio Networks: The complete Spectrum Cycle” 1st Edition, CRC press Taylor and Francis Group, 2015. 2. Ahamed Khattab, Dmitri Perkins, Bagdy Byoumi, “Cognitive Radio Networks from Theory to practice” 3rd Edition, Springer, 2014.		

3. Kwang– Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks, 1st Edition, Wiley, 2009.
REFERENCES:
1. Alexander M.Wyglinski, Maziar Nekovee, Thomas Hou,” Cognitive Radio Communications and Networks”. 1st Edition, Elsevier Science, 2009.
2. Bruce Fette, “Cognitive radio technology”, 2nd edition, Elsevier, 2009.
3. Huseyin Arslan, “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, 2nd Edition, Springer, 2007.

21PEC40	SPACE TIME WIRELESS COMMUNICATION	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To explain the concepts of signal and channel models for various multiple antenna techniques. • To outline the channel capacity of space time wireless channels. • To explore transmit diversity concept under various channel constraints. • To demonstrate various receiver structure of multiple antenna configuration. • To illustrate the receiver structures concepts of multiple antenna systems.					
UNIT I	SPACE TIME SIGNAL AND CHANNEL MODEL				9
Space time signal model: SISI, SIMO, MISO and MIMO, Space time channel model: SISO, SIMO, MISO and MIMO, Extended channel models: Spatial fading correlation, LOS component, Cross-polarized antennas and Degenerate channels, Statistical properties of channel: Singular value and Squared Frobenius norm.					
UNIT II	CAPACITY OF SPACE TIME WIRELESS CHANNELS				9
Frequency flat fading channel with perfect CSIT, Frequency flat fading channel in the absence of CSIT, Frequency selective fading channel with perfect CSIT, Frequency selective fading channel in the absence of CSIT, Random MIMO channel, Correlated MIMO channel.					
UNIT III	SPATIAL DIVERSITY				9
Diversity gain: Coding gain vs diversity gain, Spatial diversity vs time/frequency diversity,					

transmit antenna diversity: Channel unknown to the transmitter – MISO, Channel known to the transmitter – MISO, Channel unknown to the transmitter – MIMO, Channel known to the transmitter – MIMO, Receive diversity: Selection, Threshold, Equal gain and Maximal ratio combining.		
UNIT IV	RECEIVER STRUCTURES	9
Maximum likelihood receiver, Zero forcing receiver, Minimum mean square error, Decision feedback error, D-BLAST and V- BLAST.		
UNIT V	SPACE TIME OFDM	9
SISO – OFDM, MIMO – OFDM modulation, Signaling and receivers for MIMO – OFDM: Spatial diversity coding for MIMO – OFDM, SM for MIMO – OFDM and Space-frequency coded MIMO – OFDM		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate signal and channel model multiple antenna systems. CO2: Develop the channel fadings and capacity of space time channels. CO3: Explain various diversity techniques. CO4: Analyze the performance of various receiver structures. CO5: Summarize the concepts of multi-antenna systems.		
TEXT BOOKS: 1. D.Tse and P. Viswanath, “Fundamentals of Wireless Communications”, 1 st Edition, Cambridge University Press, 2005. 2. Erik. G. Larsson, “Space Time Block Coding for Wireless Communications”, 2 nd Edition, Cambridge University Press, 2003. 3. William.C.Y.Lee, “Mobile Cellular Telecommunications-Analog and Digital Systems”, 2 nd Edition, Tata McGraw Hill Edition, 2017.		
REFERENCES: 1. A.B.Gershman, N.D.Sidiropoulos, “Space Time Processing for MIMO Communications”, 4 th Edition, John Wiley, 2005. 2. Mohinder Jankiraman, “Space-time codes and MIMO systems”, 1 st Edition, Artech House, Boston, London, 2004.		

3. Paulraj Rohit Nabar, Dhananjay Gore, “Introduction of space time wireless communication systems”, 1st Edition, Cambridge University Press, 2003.

21PEC41	MASSIVE MIMO SYSTEMS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To learn the basics of massive MIMO systems. - To explain the key technologies on capacity bounding. - To explore the characteristics of single and multiple cells. - To gain knowledge on power control techniques of massive MIMO systems. - To know the recent research trends in massive MIMO systems.					
UNIT I	INTRODUCTION TO MIMO				9
Evolution of cellular systems from 1G to 4G and the principles underlying different generations, Engineering requirements and application scenarios for 5G, Role of massive MIMO as a key 5G solution, Characteristics and benefits of massive MIMO systems, signal and channel models, Differences with respect to point-to-point MIMO and multiuser MIMO, time division and frequency division duplex modes of operation.					
UNIT II	MATHEMATICAL PRELIMINARIES AND CAPACITY AND CAPACITY BOUNDING TECHNIQUES				9
Circular symmetric complex Gaussian random vectors, Few random matrix results, Wishart distributions, detection and estimation in additive Gaussian noise, Fading channels, capacity for point-to-point scalar channels, point-to-point MIMO channels, and multiuser MIMO channels, discussion on few capacity bounding tools.					
UNIT III	SINGLE AND MULTIPLE CELL ANALYSIS				9
Uplink training and channel estimation, uplink data transmission, zero-forcing and maximum ratio detection, downlink data transmission, zero-forcing and maximum ratio precoding, derivation of spectral efficiency results; pilot contamination and its effects, asymptotic analysis.					
UNIT IV	POWER CONTROL IN MASSIVE MIMO SYSTEMS				9

Single cell, multiple cells, max-min fairness; Propagation channels: Conditions for favorable propagation, independent Rayleigh fading, uniformly random line-of-sight channels; Case studies: Examples of single and multiple cell deployment.		
UNIT V	APPLICATIONS OF MASSIVE MIMO	9
Pilot Decontamination, Effects of hardware impairments, Massive MIMO with FDD operation Cell-free Massive MIMO; Other potential 5G technologies such as device to device communications and applicability of massive MIMO to small cells and mmwave communications.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners should be able to CO1: Explain the major cellular communication standards and wireless communications networks. CO2: Illustrate the 5G techniques for the design of communication systems. CO3: Demonstrate various modulation and multiplexing techniques. CO4: Outline Machine Learning algorithms in 5G Wireless Communications. CO5: Summarize the recent research works in massive MIMO systems.		
TEXT BOOKS: 1. T. L. Marzetta, E. G. Larsson, H. Yang, and H. Q. Ngo, Fundamentals of Massive MIMO, 1 st Edition, Cambridge University Press, 2016. 2. D. Tse and P. Viswanath, Fundamentals of Wireless Communication, 1 st Edition, Cambridge University Press, 2005. 3. H. Yang and T. S. Quek, Massive MIMO meets Small Cell: Backhaul and Cooperation, Springer, 2016.		
REFERENCES: 1. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, 1 st Edition, Cambridge University Press, 2017. 2. W. Xiang, K. Zheng, and X. Xuemin, 5G Mobile communications, Springer, 2017. 3. J. Rodriguez, Fundamentals of 5G Mobile Networks, John Wiley & Sons, 2015.		

21PEC42	MILLIMETER WAVE COMMUNICATIONS	L	T	P	C
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COURSE OBJECTIVES: - To outline the characteristics and applications of millimeter wave. - To illustrate the fundamentals of millimeter wave devices and circuits. - To know the various components of millimeter wave communications system. - To interpret the concepts of millimeter wave MIMO systems. - To infer about antenna design at millimeter wave frequencies.						
UNIT I		INTRODUCTION TO MMWAVE COMMUNICATION				9
Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.						
UNIT II		MM WAVE DEVICES AND CIRCUITS				9
Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.						
UNIT III		MM WAVE COMMUNICATION SYSTEMS				9
Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations.						
UNIT IV		MM WAVE MIMO SYSTEMS				9
Massive MIMO communications, Spatial diversity of antenna arrays, Multiple antennas, Multiple transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.						
UNIT V		ANTENNAS FOR MM WAVE SYSTEMS				9
Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device						

to Device communications over 5G systems, Design techniques of 5G mobile.
TOTAL: 45 PERIODS
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the characteristics of millimeter wave. CO2: Infer the properties of millimeter wave devices and circuits. CO3: Explain about the usage of millimeter wave communication systems. CO4: Outline the characteristics of millimeter wave MIMO systems. CO5: Design antenna for millimeter wave frequencies.
TEXT BOOKS: 1. K.C. Huang and Z. Wang, "Millimeter Wave Communication Systems", 2 nd Edition, Wiley-IEEE Press, March 2011. 2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport and Murdock, "Millimeter Wave Wireless Communication", 4th Edition, Prentice Hall, 2014. 3. Sergey M. Smolskiy Author, Leonid A. Belov and Victor N. Kochemasov, "Handbook of RF, Microwave, and Millimeter-Wave Components", 1st Edition, Artech House Microwave Library, 2012.
REFERENCES: 1. Xiang, W; Zheng, K and Shen, X.S; "5G Mobile Communications", 2nd Edition, Springer, 2016. 2. Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, "Millimeter – Wave Wireless Communication Systems: Theory and Applications," 2nd Edition Hindawi Publishing Corporation, 2007. 3. John S. Seybold "Introduction to RF propagation," John Wiley and Sons, 2005.

VERTICAL VII

SEMICONDUCTOR CHIP DESIGN AND TESTING

21PEC43	WIDE BANDGAP DEVICES	L	T	P	C
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COURSE OBJECTIVES:							
• To outline the fundamental properties of wide bandgap semiconductors. • To explain the properties of various photonic devices. • To summarize various wide bandgap devices. • To illustrate nanostructure materials and related devices. • To outline novel heterostructure devices.							
UNIT I	FUNDAMENTALS OF WIDE BANDGAP SEMICONDUCTORS						9
Optical Devices - Wide Bandgap Semiconductors Indispensable for Short Wavelength Optical Devices - Characteristics and Trends of Wide Bandgap Semiconductor Optical Devices- Silicon Carbide Electronic Devices - Nitride Compound Semiconductor Electron Devices - Crystals and Band Structure - Optical, Mechanical, and Thermal Properties of Wide Bandgap Semiconductors - Electrical Properties of Wide Bandgap Semiconductors.							
UNIT II	PHOTONIC DEVICES						9
Physical Properties - Visible LEDs - Ultraviolet Devices - White Light Emitting Devices - Laser Diodes							
UNIT III	ELECTRONIC DEVICES						9
High Frequency Power Devices - High Breakdown Voltage, High Current Density Power Devices - Electron Emitters - Transparent Devices.							
UNIT IV	NANOSTRUCTURE DEVICES AND MATERIALS						9
Single Photon Devices - GaN Nano column Light Emitting - Wide Bandgap Semiconductor Nanostructures and Devices.							
UNIT V	NOVEL HETEROSTRUCTURE DEVICES						9
GaN-Based High Temperature Operating Hall Devices - GaN-Based Inter subband Transition Optical Switches - Nitride Photocatalysis.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:							
At the end of the course, learners will be able to							

CO1: Outline the fundamental properties of wide bandgap semiconductors.
CO2: Interpret the properties of various photonic devices.
CO3: Summarize various wide bandgap devices.
CO4: Illustrate nanostructure materials and related devices.
CO5: Analyze the characteristics of various heterostructure devices.
TEXT BOOKS: 1. Kiyoshi Takahashi, Akihiko Yoshikawa and Adarsh Sandhu, “Wide Bandgap Semiconductors - Fundamental Properties and Modern Photonic and Electronic Devices”, 1st Edition, Springer, 2007. 2. Fei (Fred) Wang, Zheyu Zhang, and Edward A. Jones, “Characterization of Wide Bandgap Power Semiconductor Devices”, 1st Edition, The Institution of Engineering and Technology, 2018. 3. B. Jayant Baliga, “Wide Bandgap Semiconductor Power Devices: Materials, Physics, Design and Applications”, 1st Edition, Woodhead Publishing, 2019.
REFERENCES: 1. Fan Ren and John C. Zolper, “Wide Energy Bandgap Electronic Devices”, 1st Edition, World Scientific, 2004. 2. UttamSingiseti, Towhidur Razzak, Yuewei Zhang, “Wide Bandgap Semiconductor Electronics and Devices”, 1st Edition, World Scientific Publishing Company; 2019. 3. Fan Ren, Stephen J Pearton, “Wide Bandgap Semiconductor-Based Electronics”, 1st Edition, IOP Publishing Limited, 2020.

21PEC44	ASIC DESIGN	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To explain the concepts of ASIC, CMOS logic and ASIC Design libraries. • To illustrate the programmable ASIC IO and logic cells. • To expose programmable ASIC Architecture. • To learn about logic synthesis, placement and routing in ASIC design. • To explain the concept of System on Chip (SoC) and its applications.					

UNIT I	INTRODUCTION TO ASICS AND ASIC LIBRARY DESIGN	9
Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.		
UNIT II	PROGRAMMABLE ASICS, ASIC LOGIC CELLS AND ASIC I/O CELLS	9
Anti fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA – Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.		
UNIT III	PROGRAMMABLE ASIC ARCHITECTURE	9
Architecture and configuration of Spartan / Cyclone and Virtex / Stratix FPGAs – Micro-Blaze / Nios based embedded systems – Signal probing techniques.		
UNIT IV	LOGIC SYNTHESIS, PLACEMENT AND ROUTING	9
Logic synthesis - ASIC floor planning- placement and routing – power and clocking strategies.		
UNIT V	HIGH PERFORMANCE ALGORITHMS AND CASE STUDIES	9
DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. Case Studies: Digital camera, SDRAM, High speed data standards.		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Describe architecture of programmable devices. CO2: Outline the concepts of programmable ASIC logic cells. CO3: Demonstrate the Programmable ASIC Architecture. CO4: Illustrate the logic synthesis, placement and routing. CO5: Model real-time case studies of system on chip concepts.		
TEXT BOOKS: 1. M.J.S. Smith, “Application Specific Integrated Circuits”, 1 st Edition, Pearson Education, 2008 2. Farzad Nekoogar and Faranak Nekoogar, “From ASICs to SOCs: A Practical		

Approach”, 1st Edition, Prentice Hall PTR, 2003. 3. Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, “FPGA-based Implementation of Signal Processing Systems”, 2nd Edition, Wiley, 2017.
REFERENCES: 1. Douglas J. Smith, “HDL Chip Design, Madison”, 1st Edition, Doone Publications, 2002. 2. Jose E. France, YannisTsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", 1st Edition, Prentice Hall, 1994. 3. Khosrow Golshan, “Physical Design Essentials: An ASIC Design Implementation Perspective” 1st Edition, Springer US, 2007.

21PEC45	LOW POWER IC DESIGN	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To analyze various sources of power dissipation in CMOS circuits. • To optimize the circuit structures for reduced power consumption. • To apply the special and advance techniques to design CMOS low power circuits. • To estimate the power for CMOS circuits. • To analyze the software design for power optimization.					
UNIT I	POWER DISSIPATION CONCEPTS	9			
Basic principle of low power design -Low power figure of merits-Sources of power consumption – Physics of power dissipation in CMOS FET devices –Reducing power consumption in memories-SRAM-DRAM.					
UNIT II	POWER OPTIMIZATION	9			
Logic level power optimization – Circuit level low power design – circuit techniques for reducing power consumption in adders and multipliers.					
UNIT III	DESIGN OF LOW POWER CMOS CIRCUITS	9			
Computer arithmetic techniques for low power system – low power clock, Interconnect and					

layout design –Advanced techniques –adiabatic-pass transistor logic synthesis–asynchronous circuits-Special techniques- power reduction in clock networks-CMOS floating gate- delay balancing.		
UNIT IV	POWER ESTIMATION	9
Power Estimation technique – Modelling of signals–signal probability using BDD-Statistical techniques-Estimating of glitching power- logic power estimation – power estimation methodologies-Monte Carlo power estimation– Simulation power analysis – Probabilistic power analysis- signal entropy.		
UNIT V	SYNTHESIS AND SOFTWARE DESIGN	9
Behavioral level transforms - Logic level optimizations for low power-Circuit level. Software design for low power - Sources of Software Power Dissipation - Software for Power Estimation - Software Power Optimization.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Analyze various sources of power dissipation in CMOS circuits CO2: Develop optimized circuit structures to reduce the power consumption. CO3: Demonstrate CMOS low power circuits using various techniques CO4: Summarize the power for CMOS circuits. CO5: Make use of software design optimization to reduce the power consumption.		
TEXT BOOKS: 1. Dimitrios.S, Chirstian.P, “Designing CMOS Circuits for Low Power”, 1 st Edition, Kluwer, 2011. 2. Kaushik Roy and S.C.Prasad, “Low power CMOS VLSI circuit design”, 1 st Edition, Wiley, 2009. 3. John Rabaey,“ Lowpower design essentials” 1 st Edition, Springer, 2009.		
REFERENCES: 1. J.B.Kulo and J.H Lou, “Low voltage CMOS VLSI Circuits”, 1 st Edition, Wiley, 2002. 2. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, 1 st Edition, Kluwer, 1995. 3. Gary Yeap, “Practical low power digital VLSI design”, 1 st Edition, Kluwer, 1998.		

4. Abdelatif Belaouar and Mohamed Elmasry, “Low power digital VLSI design”, 1 st Edition, Kluwer, 2012.
5. James B.Kulo, Shih-Chia Lin, “Low voltage SOI CMOS VLSI devices and Circuits”, 1 st Edition, John Wiley and sons, 2008.

21PEC46	DESIGN FOR TESTABILITY OF VLSI CIRCUITS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the basic testing process of digital circuits. • To explain the process of generation of test input for combinational and sequential circuits. • To construct circuits for testability for digital circuits. • To outline the test patterns for digital circuits. • To illustrate the methods of fault diagnosis for combinational circuits.					
UNIT I	FUNDAMENTALS OF TESTING AND FAULT MODELLING	9			
Introduction to testing – Faults in Digital Circuits – Modelling of faults – Logical Fault Models – Fault detection – Fault Location – Fault dominance – Logic simulation – Types of simulation – Delay models – Gate Level Event – driven simulation					
UNIT II	TEST GENERATION FOR COMBINATIONAL AND SEQUENTIALCIRCUITS	9			
Test generation for combinational logic circuits – Testable combinational logic circuit design – Test generation for sequential circuits – design of testable sequential circuits.					
UNIT III	DESIGN FOR TESTABILITY	9			
Design for Testability – Ad-hoc design – generic scan based design – classical scan based design – system level DFT approaches					
UNIT IV	SELF TEST AND TEST ALGORITHMS	9			
Built-In self Test – test pattern generation for BIST – Circular BIST – BIST Architectures– Testable Memory Design – Test Algorithms – Test generation for Embedded RAMs					
UNIT V	FAULT DIAGNOSIS	9			

Logical Level Diagnosis – Diagnosis by UUT reduction – Fault Diagnosis for Combinational Circuits – Self-checking design – System Level Diagnosis.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of this course, learners will be able to

- CO1: Illustrate the testing process and fault modeling for digital circuits.
- CO2: Outline the generation of testing circuits for combinational and sequential circuits.
- CO3: Develop the test circuits for testing the digital circuits.
- CO4: Illustrate the testing algorithms and its patterns.
- CO5: Analyze various fault diagnosis processes for combinational circuits.

TEXT BOOKS:

1. M.Abramovici, M.A.Breuer and A.D. Friedman, “Digital Systems and Testable Design”, 1st Edition, Jaico Publishing House, 2001.
2. P.K. Lala, “Digital Circuit Testing and Testability”, 1st Edition, Academic Press, 1997.
3. N.K.Jha, S.Gupta, “Testing of Digital systems”, 1st Edition, Cambridge University Press, 2012.

REFERENCES:

1. M.L.Bushnell and V.D.Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, 1st Edition, Kluwer Academic Publishers, 2004.
2. A.L.Crouch, “Design Test for Digital IC’s and Embedded Core Systems”, 1st Edition, Prentice Hall International, 2004.
3. Sobhit Saxena, Suman Lata Tripathi, Sushanta Kumar Mohapatra, “Advanced VLSI Design and Testability Issues”, 1st Edition, CRC Press, 2020.

21PEC47	MIXED SIGNAL IC DESIGN	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the MOS characteristics, large signal model /small signal model and its analysis. • To interpret the submicron circuit, its process flow and delay elements.					

• To infer the characteristics and architectures of different types of data converters. • To illustrate SNR and filters for data converters. • To infer about the switched capacitor amplifier circuits.		
UNIT I	INTRODUCTION AND BASIC MOS DEVICES	9
Challenges in analog design-Mixed signal layout issues- MOSFET structures and characteristics- large signal and small signal model of single stage Amplifier-Source follower-Common gate stage – Cascode stage – large and small signal analysis of differential amplifier with active load, pole-zero estimation, zero value time constant method, frequency response of CS, cascade amplifiers.		
UNIT II	SUBMICRON CIRCUIT DESIGN	9
Submicron CMOS process flow, Capacitors and Resistors, Current mirrors, Digital circuit design, Delay elements – Adders- Op-amp parameters and design.		
UNIT III	DATA CONVERTERS	9
Static and dynamic errors in DAC and ADC – Architectures & Characteristics of Sample and Hold- Digital to Analog Converters- DAC- R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC.		
UNIT IV	SNR IN DATA CONVERTERS	9
Overview of SNR of Data converters- Clock Jitters- Improving techniques averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating filters for DAC.		
UNIT V	SWITCHED CAPACITOR CIRCUITS	9
Resistors, First order low pass circuit, Switched capacitor amplifier, Switched capacitor integrator – Design of flip around sample and hold circuit – pipelined ADC.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Outline the characteristics and model of MOS circuits. CO2: Illustrate the Submicron circuits and its delay elements. CO3: Explain the characteristics and architectures of different types of data converters.		

CO4: Compare the SNR of data converters.
CO5: Develop switched capacitor circuits.
TEXT BOOKS: 1. J. Jacob Wikner, Mikael Gustavsson and Nianxiong Tan, “CMOS Data Converters for Communications”, 1st Edition, Springer, 2002. 2. Van de Plassche, Rudy J., “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters”, 2nd Edition, Springer, 2003. 3. Vineeta P.Gejj, “Analog and Mixed mode VLSI Design”, 1st Edition, PHI Learning Pvt. Ltd., 2011.
REFERENCES: 1. Gray, Meyer, Lewis, Hurst, “Analysis and design of Analog IC’s”, 4th Edition, Wiley International, 2002. 2. Phillip E.Allen Douglas R. Holberg, “CMOS Analog Circuit Design”, 3rd Edition, Oxford University Press, 2003. 3. R.Jacob Baker, “CMOS: Mixed-Signal Circuit Design”, 1st Edition, IEEE press series, Wiley, 2008

21PEC48	SYSTEM ON CHIP	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: • To outline the system architecture and its approach for SOC design. • To know about the processor architecture. • To illustrate the memory design for SOC. • To explain about the interconnect architectures. • To interpret the reconfigurable technologies.					
UNIT I	INTRODUCTION TO THE SYSTEM APPROACH				9
System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, an approach for SOC Design, System Architecture and Complexity.					
UNIT II	PROCESSORS				9

Processor Selection for SOC, Basic concepts in Processor Architecture, Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.		
UNIT III	MEMORY DESIGN FOR SOC	9
Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation , SOC Memory System, Models of Simple Processor – memory interaction.		
UNIT IV	INTERCONNECT CUSTOMIZATION AND CONFIGURATION	9
Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor		
UNIT V	INTERCONNECT CONFIGURATION	9
Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance-Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism		
TOTAL : 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Outline the concepts of system architecture. CO2: Illustrate the processor architecture and its basic elements. CO3: Demonstrate the memory system of SoC. CO4: Interpret the interconnect architecture and its configuration. CO5: Analyze the various types of reconfigurable technologies.		
TEXT BOOKS: 1. Michael J. Flynn and Wayne Luk,” Computer System Design System-on-Chip “, 1 st Edition, Wiley India Pvt. Ltd., 2011 2. Ricardo Reis ,” Design of System on a Chip: Devices and Components”,1 st Edition , Springer, 2004. 3. Farimah Farahmandi , Yuanwen Huang ,” System-on-Chip Security: Validation and		

Verification”, 1 st Edition, Springer, 2020.
REFERENCES: 1. Steve Furber, “ARM System on Chip Architecture”, 2nd Edition, Addison Wesley Professional, 2000. 2. Prakash Rashinkar, Peter Paterson and Leena Singh L,” System on Chip Verification Methodologies and Techniques”,1st Edition, Kluwer Academic Publishers, 2001. 3. Veena S. Chakravarthi, “A Practical Approach to VLSI System on Chip (SoC) Design: A Comprehensive Guide”, 1st Edition, Springer International Publishing, 2019.

21PEC49	NETWORKS ON CHIP	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To outline the basic concepts of network on chip • To explain the architecture design of NOC. • To gain knowledge about the routing algorithm and its limitations • To explore the various test and fault tolerance circuits • To know the various communication available in 3D integration of NOC					
UNIT I	INTRODUCTION TO NOC	9			
Introduction to NoC – OSI layer rules in NoC - Interconnection Networks in Network-on-ChipNetwork-Topologies - Switching Techniques - Routing Strategies - Flow Control Protocol Quality-of-Service-Support					
UNIT II	ARCHITECTURE DESIGN	9			
Switching Techniques and Packet Format - Asynchronous FIFO Design -GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design – AdaptiveRouter Architecture Design.					
UNIT III	ROUTING ALGORITHM	9			
Packet routing-Qos, congestion control and flow control – router design – network link design – Efficient and Deadlock-Free Tree-Based Multicast Routing Methods - Path-Based Multicast Routingfor 2D and 3D Mesh Networks- Fault-Tolerant Routing Algorithms - Reliable and					

AdaptiveRoutingAlgorithms		
UNIT IV	TEST AND FAULT TOLERANCE OF NOC	9
Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-onChips-Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on-Chips		
UNIT V	THREE DIMENSIONAL INTEGRATION OF NETWORK-ON-CHIP	9
Three-Dimensional Networks-on-Chips Architectures. – A Novel Dimensionally-Decomposed Routerfor On-Chip Communication in 3D Architectures - Resource Allocation for QoS On-ChipCommunication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on-Chip		
TOTAL PERIODS : 45		
COURSE OUTCOMES: At the end of this course, learners will be able to • Outline the basic concepts of NOC • Illustrate the various architectures of NOC • Summarize the routing methods and algorithms • Interpret the various tests and fault tolerance methods • Explain the 3D networks on chips and their advantages.		
TEXT BOOKS: 1. ChrysostomosNicolopoulos, Vijaykrishnan Narayanan, Chita R.Das,” Networks-on – ChipArchitectures Holistic Design Exploration”, 1st Edition, Springer, 2009. 2. Fayezegebali, Haythamelmiligi, HqahedWatheq E1-Kharashi “Networks-on-Chips theory andpractice”,1st Edition, CRC press, 2017. 3. Santanu Kundu, Santanu Chattopadhyay, “Network-on-Chip The Next Generation of System-on-Chip Integration”, CRC Press, 2018.		
REFERENCES: 1. Konstantinos Tatas and Kostas Siozios, "Designing 2D and 3D Network-on-Chip Architectures",1st Edition, Springer, 2013. 2. Palesi, Maurizio, Daneshtalab, Masoud “Routing Algorithms in Networks-on-Chip” 1stEdition, Springer, 2014 3. SantanuKundu, SantanuChattopadhyay “Network-on-Chip: The Next Generation of Systemon-Chip Integration”,1st Edition, CRC Press, 2014.		

VERTICAL – VIII

COMPUTATIONAL INTELLIGENCE

21PEC50	ARTIFICIAL INTELLIGENCE	L	T	P	C
		2	2	0	3
COURSE OBJECTIVE: - To outline the fundamental strategies for solving problems using AI. - To implement various AI logics. - To infer the probabilistic approach for decision making. - To analyze about various Reinforcement and Untrained Learning approaches. - To explore the AI and RL concepts for contemporary applications.					
UNIT I	ARTIFICIAL INTELLIGENCE BASED PROBLEM SOLVING				12
Intelligent Agents, Problem Formulation, Uninformed Search Strategies, Heuristics Search Strategies, Local Search Algorithms and optimization problems, Problem Decomposition and Rule Based Systems.					
UNIT II	KNOWLEDGE AND PLANNING				12
Logic and inferences: Logic Agents, First Order Logic, Forward and Backward chaining. Planning: Forward and Backward Search, Goal Stack Planning.					
UNIT III	REASONING AND DECISION MAKING				12
Reasoning: Quantifying Uncertainty and Probabilistic Reasoning–Semantics and Inference in Bayesian Networks, Probabilistic Reasoning over time – Hidden Markov Models, Kalman filters. Decision Making: Sequential Decision Problems, Value Iteration, Policy Iteration, Markov Decision Process (MDP).					
UNIT IV	REINFORCEMENT LEARNING				12
Forms of Learning, Elements of Reinforcement Learning (RL), Agent - Environment Interface, Passive RL, Active RL, Multi-armed Bandit, Monte Carlo Method, Temporal Difference Learning, Eligibility Traces, DQN and Policy Gradient Approaches.					

UNIT V	AI AND RL APPLICATION	12
Future of AI, RL applications, Case study: Alpha Go, Universal Robots - cobots, Mars Curiosity Rover and Sophia.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Outline various strategies for AI. CO2: Develop AI logics for planning. CO3: Make use of Decision Making Rules for developing AI models. CO4: Analyze various RL algorithms. CO5: Demonstrate AI and RL based application specific systems.		
TEXT BOOKS: 1. Russell, S.J. and Norvig, P., “Artificial intelligence – A modern approach”, 3rd Edition, Pearson, 2015. 2. Richard S. Sutton, Andrew G Barto, “Reinforcement Learning – An Introduction”, 1st Edition, MIT, Press, 2018. 3. Csaba Szepesvari, “Algorithms for Reinforcement Learning”, 1st Edition, Morgan and Claypool Publishers, 2010.		
REFERENCES: 1. M. Nagenevsky, “Artificial Intelligence – a guide to intelligent systems”, 3rd Edition, Addison Wesley, 2011. 2. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, “Probabilistic Robotics”, 1st Edition, MIT Press, 2005. 3. Deepak Khemani, “A First Course in Artificial Intelligence”, 1st Edition, McGraw Hill Education, 2017.		

21PEC51	PATTERN RECOGNITION	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					

• To learn the fundamental concepts of Pattern Recognition. • To know about feature extraction and selection methods. • To explore about supervised and unsupervised learning concepts. • To understand the basics of Neural Networks. • To know about the various applications of Pattern Recognition.		
UNIT I	PATTERN RECOGNITION CONCEPTS	9
Fundamental concepts and blocks of a typical pattern recognition system. Decision functions- role and types, pattern and weight space, properties and implementation of decision functions.		
UNIT II	FEATURE SELECTION	9
Feature identification, selection and extraction. Distance measures, clustering transformation and feature ordering, clustering in feature selection, feature selection through maximization and approximations.		
UNIT III	SUPERVISED AND UNSUPERVISED LEARNING	9
Pattern classification by distance functions. Clusters and cluster seeking algorithms. Pattern classification by likelihood functions. Baye's classifier and performance measures.		
UNIT IV	NEURAL NETWORKS	9
Artificial neural network model, Neural network-based pattern associators, Feed forward networks and training by back-propagation- Deep neural networks, convolutional neural networks and recurrent neural networks.		
UNIT V	APPLICATIONS OF PATTERN RECOGNITION	9
Applications of statistical and neural network – based pattern classifiers in speech recognition, image recognition and target recognition.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Summarize the basics of Pattern Recognition. CO2: Infer the various feature selection methods. CO3: Categorize the various pattern recognition techniques into supervised and unsupervised.		

CO4: Illustrate the artificial neural network based pattern recognition.
CO5: Relate the applications of pattern recognition.
TEXT BOOKS: 1. Earl Gose, R.Johnson Baugh and Steve Jost, “Pattern Recognition and Image Analysis”, Pearson, 2015. 2. Richard O.Duda, Peter E.Hart and David G.Stork, “Pattern Classification”, 2nd Edition, Wiley India, 2006. 3. J.I. Tou& R.C. Gonzalez, “Pattern Recognition Principles”, Addition-Wesley, 1997.
REFERENCES: 1. Christopher. M. Bishop, “Pattern recognition and machine learning”, Springer, 2006. 2. S Theodoridis, K Koutroumbas, “Pattern Recognition”, 4th Edition, Academic Press, 2009. 3. Robert J.Schalkoff, “Pattern Recognition Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 1992.

21PEC52	SOFT COMPUTING TECHNIQUES	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To explain the types of soft computing techniques. • To outline the types of Artificial Intelligence and Production Systems. • To gain the knowledge about different types of perceptions. • To explain Fuzzy Logic, Various fuzzy systems and their functions. • To learn the applications and advances of Genetic Algorithms.					
UNIT I	INTRODUCTION TO SOFTCOMPUTING				9
Introduction to soft computing, soft computing vs. hard computing, Types of soft computing techniques, Sequential and Parallel Computing. Applications of soft computing: Healthcare, Remote Sensing and Communication Systems.					
UNIT II	ARTIFICIAL INTELLIGENCE				9

Introduction, Various types of production systems, characteristics of production systems. Search Techniques: Breadth first search, Depth first search, Hill Climbing, Best first search. A* and AO* Algorithms and control strategies. Knowledge representation issues, Propositional and predicate logic, monotonic and non monotonic reasoning, forward and backward reasoning, Strong slot and weak slot filler structure.		
UNIT III	NEURAL NETWORKS	9
Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, Difference between ANN and human brain, characteristic and applications of ANN, single layer network. Perceptron training algorithm, Linear separability, Widrow & Hebb's learning rule/Delta rule. Introduction of MLP, activation functions, Error calculation, back propagation algorithm, momentum, limitation, characteristics and application of BPAs.		
UNIT IV	FUZZY LOGIC AND FUZZY SYSTEMS	9
Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, features of membership functions. Fuzzy propositions, formation, decomposition & aggregation of fuzzy Rules, fuzzy reasoning, fuzzy decision making & Applications of fuzzy logic.		
UNIT V	GENETIC ALGORITHM AND APPLICATIONS	9
Fundamental basic concepts: working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion, deletion, mutation operator and Bitwise operator. Generational Cycle, Convergence of GA, Differences & similarities between GA and other traditional methods, Applications & advances in GA.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Outline soft computing techniques and their applications. CO2: Analyze various neural network architectures. CO3: Explain perceptrons and propagation networks. CO4: Demonstrate the fuzzy systems and fuzzy rules. CO5: Analyze the genetic algorithms and their applications.		
TEXT BOOKS: 1. S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing", 2 nd Edition, Wiley Publications, 2011.		

2. S. Rajasekaran and G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications”, 1st Edition, PHI Publication, 2009.
3. George J Klir and Bo Yuan, “Fuzzy sets & Fuzzy Logic, Theory & Applications”, 1st Edition, PHI Publication, 2009.

REFERENCES:

1. N.K.Bose and Ping Liang, “Neural Network fundamental with Graph, Algorithms & Applications”, 1st Edition, TMH, 1998.
2. Bart Kosko, “Neural Network & Fuzzy System”, 1st Edition, PHI Publication, 2009.
3. Rich E and Knight K, “Artificial Intelligence”, 3rd Edition, TMH, 2012.

21PEC53	MACHINE LEARNING	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To outline the basic concepts and techniques of Machine Learning. • To learn about Supervised and Unsupervised Learning Techniques. • To explain the various Probability Based Learning Techniques. • To explore the Dimensionality Reduction and Evolutionary Models. • To interpret the Graphical Models.					
UNIT I	INTRODUCTION TO LEARNING				12
Learning – Types of Machine Learning: Supervised Learning, The Brain and the Neuron, Design a Learning System, Perspectives and Issues in Machine Learning, Concept Learning Task, Concept Learning as Search, Finding a Maximally Specific Hypothesis, Version Spaces and the Candidate Elimination Algorithm, Linear Discriminants, Perceptron, Linear Separability, Linear Regression.					
UNIT II	LINEAR MODELS				12
Multi-layer Perceptron, Going Forwards, Going Backwards: Back Propagation Error-Multi-layer Perceptron in Practice, Examples of using the MLP- Overview. Deriving Back Propagation, Radial Basis Functions and Splines: Concepts, RBF Network. Curse of Dimensionality–Interpolations and Basis Functions–Support Vector Machines.					

UNIT III	TREE AND PROBABILISTIC MODELS	12
Learning with Trees: Decision Trees, Constructing Decision Trees, Classification and Regression Trees. Ensemble Learning, Boosting, Bagging. Different ways to Combine Classifiers, Probability and Learning. Data into Probabilities- Basic Statistics. Gaussian Mixture Models, Nearest Neighbor Methods, Unsupervised Learning, K- means Clustering Algorithms.		
UNIT IV	DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS	12
Dimensionality Reduction, Linear Discriminant Analysis. Principal Component Analysis, Factor Analysis, Independent Component Analysis, Locally Linear Embedding. Isomap, Least Squares Optimization, Evolutionary Learning: Genetic algorithms – Genetic Offspring: - Genetic Operators. Reinforcement Learning – Markov Decision Process		
UNIT V	GRAPHICAL MODELS	12
Markov Chain, Monte Carlo methods. Sampling, Proposal distribution. Graphical models. Bayesian networks, Markov Random Fields, Hidden Markov models, Tracking methods		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Make use of the appropriate machine learning strategy for any given problem. CO2: Compare supervised, unsupervised and semi-supervised learnings. CO3: Outline the role of Probabilistic models in learning. CO4: Explain dimensionality reduction algorithms. CO5: Illustrate the graph models of machine learning.		
TEXT BOOKS: 1. Ethem Alpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, 3 rd Edition, MIT Press, 2014. 2. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, 2 nd Edition, Chapman and Hall/ CRC Machine Learning and Pattern Recognition Series, 2014. 3. Tom Mitchell, “Machine Learning”, 1 st Edition, McGraw Hill Education, 2013.		
REFERENCES:		

1. Jason Bell, “Machine learning- Hands on for Developers and Technical Professionals”, 1st Edition, Wiley, 2014.
2. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, 1st Edition, Cambridge University Press, 2012.
3. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

21PEC54	DEEP LEARNING TECHNIQUES	L	T	P	C
		2	2	0	3
COURSE OBJECTIVES: • To outline the concept of deep learning and fundamental mathematics required for deep learning. • To infer the modern practical deep networks and their applications. • To explain the research methods of deep learning. • To know about the various deep generative models. • To summarize the applications of deep learning networks.					
UNIT I	INTRODUCTION AND PREREQUISITE MATHEMATICS	12			
Introduction – Historical trends in deep learning - Linear algebra – Scalars – Vectors – Matrices and Tensors – Linear dependence and span - Probability and information theory – The chain rule of conditional probability - Bayes rule – Machine learning basics –Supervised and Unsupervised learning algorithms – Stochastic gradient descent.					
UNIT II	MODERN PRACTICAL DEEP NETWORKS	12			
Deep feed forward networks – Gradient based learning – Back propagation and other differentiation algorithms – Regularization for deep learning: Parameter norm penalties – Norm penalties as constrained optimization – Challenges in training deep models – Convolution networks operation – Pooling – Recurrent neural networks – Bidirectional RNNs – Deep recurrent networks – Recursive neural networks.					
UNIT III	DEEP LEARNING RESEARCH	12			
Probabilistic PCA and factor analysis - Independent Component Analysis (ICA) –Auto encoders - Representation learning- Greedy layer-Wise unsupervised pretraining - Transfer learning and Domain adaptation - Semi-supervised disentangling of causal factors - Structured probabilistic models for deep learning -The challenge of unstructured modeling - Using graphs to describe model structure - Sampling from graphical models - Learning about					

dependencies - Inference and approximate inference.		
UNIT IV	DEEP GENERATIVE MODELS	12
Boltzmann machines - Restricted Boltzmann machines - Deep belief networks – Deep boltzmann machines - Boltzmann machines for real valued data - Convolutional Boltzmann machines - Boltzmann machines for structured or sequential outputs - other Boltzmann machines – Back propagation through random operations - Directed generative nets - Drawing samples from auto encoders - Generative stochastic networks -Other generation schemes - Evaluating generative models.		
UNIT V	APPLICATION AND VISUALIZATION	12
Large scale deep learning – Computer vision – Speech recognition – Natural language processing – Other applications - Visualizations - Visual data analysis techniques - Interaction techniques – Social network analysis – Collective inferencing.		
TOTAL: 60 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to - CO1: Make use of mathematical concepts to know the fundamentals of deep learning algorithms. - CO2: Select a suitable optimization strategy for deep learning implementation. - CO3: Outline the research modes of deep learning. - CO4: Illustrate suitable deep learning models with suitable justification. - CO5: Plan a suitable visualization technique for the deep learning applications.		
TEXT BOOKS: 1. Ian Good fellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, 1st Edition, MIT Press, 2016. 2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, 1st Edition, MIT Press, 2012. 3. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.		
REFERENCES: 1. Yusuke Sugomori, "Java Deep Learning Essentials", 1st Edition, PACKT, 2016. 2. Timothy Masters, “Deep Belief Nets in C++ and CUDA C: Volume 1: Restricted Boltzmann Machines and Supervised Feed Forward Networks”, 1st Edition, Springer,		

2015.

3. Jeff Heaton, “Artificial Intelligence for Humans, Volume 3: Deep Learning and Neural Networks”, 1st Edition, Heaton Research, 2015

21PEC55	DIGITAL FORENSICS	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
• To outline the fundamentals concepts of digital forensics. • To know about various stages of investigations. • To be familiar with the acquisition and identification analysis. • To explore about the evidence processing in forensics analysis. • To gain knowledge on the available software and hardware tools.					
UNIT I	FUNDAMENTALS OF FORENSICS				9
Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.					
UNIT II	PROCEDURES OF INVESTIGATIONS				9
Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.					
UNIT III	ACQUISITION AND ANALYSIS OF DIGITAL EVIDENCE				9
Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.					
UNIT IV	EVIDENCE PROCESSING AND DIGITAL FORENSICS ANALYSIS				9
Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.					
UNIT V	SOFTWARE AND HARDWARE TOOLS				9
Current computer forensics tools- software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail					

investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

- CO1: Illustrate the basics of digital forensics.
- CO2: Outline different types of investigations.
- CO3: Summarize evidence collection on digital devices.
- CO4: Analyze and validate evidences collected from various sources.
- CO5: Apply various tools to analyze collected evidence.

TEXT BOOKS:

1. Warren G. Kruse II and Jay G. Heiser, “Computer Forensics: Incident Response Essentials”, Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., “Guide to Computer Forensics and Investigations, 2nd Edition., Thomson Course Technology, 2006.
3. Sammons, J, “The basics of digital forensics: The primer for getting started in digital forensics”, Elsevier, 2012.

REFERENCES:

1. Vacca, J, “Computer Forensics, Computer Crime Scene Investigation”, 2nd Edition, Charles River Media, 2005, ISBN: 1-58450-389.
2. Nelson, Phillips Enfinger, Steuart, “Computer Forensics and Investigations”, 6th Edition, Cengage Learning, 2018.
3. Xiaodong Lin,” Introductory Computer Forensics-A Hands on Practical Approach”, Springer 2018.

21PEC56	SWARM INTELLIGENCE	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES : • To outline the fundamentals of swarm intelligence					

• To gain knowledge about Ant colony optimization • To learn about the evolution and principles of Particle swarm optimization • To explore the artificial bee colony optimization algorithm • To outline the concepts of herd and grey wolf optimization.		
UNIT I	INTRODUCTION TO SWARM INTELLIGENCE	9
Essence of an Algorithm, Algorithms and Self –Organization, Links between Algorithms and Self-Organization, Characteristics of Meta heuristics; Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization and Krill Herd Algorithms; Strategies for state space search in AI- Depth First and Breadth First Search Heuristic Search- Best First Search and Hill Climbing.		
UNIT II	ANT COLONY OPTIMIZATION (ACO)	9
Theoretical Considerations, Combinatorial optimization and meta heuristic, Stigmergy, Convergence Proofs, ACO Algorithm, ACO and Model Based Search, Variations Of ACO: Elitist Ant System (EAS), Min max Ant System (MMAS) and Rank Based Ant Colony System (RANKAS), ACO Algorithm for Travelling Sales Person problem, ACO algorithm for feature selection.		
UNIT III	PARTICLE SWARM OPTIMIZATION	9
Principles of Bird Flocking and Fish Schooling, Evolution of PSO, Operating Principles, PSO Algorithm, Neighbourhood Topologies, Convergence Criteria, Variations of PSO.		
UNIT IV	ARTIFICIAL BEE COLONY (ABC) OPTIMIZATION	9
Behaviour of real bees, ABC Algorithm, Variations of ABC: Abcg best and Abcg best dist, Case Study: Application of ABC algorithm in solving Travelling Salesman Problem, Knapsack Problem and for feature selection.		
UNIT V	HERD OPTIMIZATION AND GREY WOLF OPTIMIZATION	9
Herding Behaviour of Krill Swarms, Lagrangian Model of Krill Herding, Methodology, Application of Krill Herd Algorithm in Feature Selection. Introduction to Elephant Herd Optimization, Grey Wolf Optimization, Applications of Elephant Herd Optimization and Grey Wolf Algorithm in Feature Selection.		

TOTAL: 45 PERIODS	
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the concepts of swarm intelligence CO2: Outline the theory of ant colony optimization algorithm CO3: Explain the principles of particle swarm optimization CO4: Interpret the applications of ABC optimization algorithm CO5: Summarize the types of herd and grey wolf optimization	
TEXT BOOKS: 1. Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, “Swarm Intelligence and Bio-Inspired Computation, Theory and Applications”, Elsevier ,2013. 2. Marco Dorigo and Thomas Stutzle, “Ant Colony Optimization”, MIT Press, Cambridge, England, 2004. 3. Hossein Rezaei, Omid Bozorg-Haddad, Xuefeng Chu, “Grey Wolf Optimization (GWO) Algorithm”, Ist Edition, Springer Singapore	
REFERENCES: 1. Ben Coppin, “Artificial Intelligence Illuminated”, Jones and Bartlett Publishers, 2004. 2. Kennedy J and Russel C Eberhart, “Swarm Intelligence”, Morgan Kaufmann Publishers, USA, 2001. 3. Dervis Karaboga, Bahriye Akay,” A comparative study of Artificial Bee Colony Algorithm” ,Applied Mathematics and Computation , Elsevier Publications, 2009.	

ONE CREDIT COURSES

21OCEC01	A PRACTICAL COURSE ON COMMUNICATION SYSTEMS – SIGNAL GENERATION AND ANALYSIS	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES: • To develop professionals with understanding of practical aspects of Industry Standard Terminology. • To understand the concept of baseband signals. • To interpret the analog and digital modulation schemes.					

LIST OF EXPERIMENTS:				
1. Study of time domain and frequency domain measurement units used in the Industry. 2. Analog and Digital signal generation. 3. Analysis of ADC and DAC blocks using simulink. 4. Analysis of filters. 5. IF processing. 6. Synchronization and equalization. 7. Analysis of Inter symbol Interference. 8. Study of signal processing techniques. 9. Analysis of baseband signals like Sine, Triangular, Ramp, Pulse. 10. Analog modulated signal generation. 11. Digital modulated signal generation. 12. Higher order IQ modulated signal generation.				
TOTAL: 15 PERIODS				
COURSE OUTCOMES:				
At the end of the course, the learners will be able to				
CO1: Interpret the terminologies of baseband communication				
CO2: Design a module for a communication system with necessary constraints.				
CO3: Design a block for M-ary digital modulation scheme.				
REFERENCES:				
1. B.Sklar, “Digital Communication Fundamentals and Applications”, 2nd Edition, Pearson Education, 2009. 2. H P Hsu, “Schaum Outline Series -Analog and Digital Communications”, 2nd Edition, TMH, 2006. 3. J.G Proakis, “Digital Communication”, 4th Edition, TMH, 2001.				

21OCEC02	A PRACTICAL COURSE ON RF MEASUREMENTS	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES :					
• To understand the basic calibration operations in network analyzer. • To perform analysis of RF filters and amplifiers.					

To measure and troubleshoot the RF transceiver parameters.
LIST OF EXPERIMENTS:
- S-parameter measurements. - Vector network analysis of RF Filter – transmission, reflection, impedance on Smith Chart. - Vector network analysis of Amplifier – gain, isolation, gain compression, AM-PM conversion. - Vector network & Spectrum analysis of RF divider/combiner – insertion loss, return loss. - Study of Spectrum Analyzer settings. - Spectrum analysis of Frequency Synthesizer and Mixer – harmonics, inter-modulation, isolation. - Study of gain, compression, harmonics and isolation. - Measurement and troubleshooting of RF Transceiver.
TOTAL: 15 PERIODS
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Make use of vector network analyzer to perform calibration for S parameter measurements. CO2: Demonstrate convolution, correlation, frequency analysis and sampling. CO3: Design RF transceivers.
REFERENCES: - Agilent Technologies, Inc., Fundamentals of RF and microwave noise figure measurements, Agilent Application Note 57-1, 2010. F. Caspers, RF engineering basic concepts: S-parameters, CAS Proc., 2010, CERN Yellow Report CERN-2011. - Agilent Technologies, Inc., Time domain analysis using a network analyzer, Agilent Application Note 1287-12, 2012.

21OCEC03	A PRACTICAL COURSE ON ANTENNA DESIGN	L	T	P	C
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	AND SIMULATION				
		0	0	2	1
COURSE OBJECTIVES: • To design the antenna with special geometry elements. • To design various types of microstrip antennas. • To design various antenna arrays.					
LIST OF EXPERIMENTS: 1. Design and simulation of Patch Antenna. 2. Design and simulation of DGS structure. 3. Design and simulation of Metamaterial Unit Cell and EBG structures. 4. Design and simulation of Implantable Antennas. 5. Design and simulation of Spiral Antenna, Circularly polarized Antenna. 6. Design and simulation of Linear Array, Planar Array. 7. Study of Vector Network Analyzer (VNA). 8. Measurement of antenna parameters using VNA.					
PROJECT 1. Any one of the Application Specific Design in Antenna or in RF Circuits					
TOTAL: 15 PERIODS					
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Design and analyze Patch Antennas and Arrays. CO2: Design antennas of frequency specific applications. CO3: Make use of the simulation tools and analyze parameters in the design of array antennas.					
REFERENCES: 1. Kraus. J.D, “Antennas”, 2nd Edition, Reprint, John Wiley and Sons, 2011. 2. Balanis.A, “Antenna Theory Analysis and Design”, 3rd Edition, John Wiley and Sons, New York, 2005. 3. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, 2nd Edition John Wiley & Sons NC, 2008.					

21OCEC04	A PRACTICAL COURSE ON EMBEDDED SYSTEMS	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES: • To expose learners to the field of Embedded Systems. • To enable learners to implement their creative concepts to work. • To understand the ARM interfacing and communication protocols					
LIST OF EXPERIMENTS: 1. Familiarization of IDE and ARM development board usage and program execution. 2. Program to blink a group of 8 LEDs with a delay. 3. Interface 4-digit seven-segment display to display any four letter word. 4. Interface stepper motor and control its speed and direction. 5. Interfacing of DC motors.					
TOTAL: 15 PERIODS					
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Develop assembly language programs to perform specific tasks using ARM instructions. CO2: Develop ARM microcontroller applications using Embedded C language. CO3: Design and develop program to interface external hardware with LPC214x micro controller.					
REFERENCES: 1. Andrew N. Sloss, Dominic Symes, Chris Wright, “ARM Systems Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers”, Elsevier Inc, 2004. 2. William Hohl, Christopher Hinds, “ARM assembly language Fundamentals and Techniques”, 2nd Edition, CRC Press, 2015. 3. Gibson, “ARM Assembly Language An Introduction”, 2nd Edition, 2007.					

21OCEC05	A PRACTICAL COURSE ON UAV SYSTEM DESIGN	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: - To design the quadcopter and UAV. - To test the propulsion system of UAV systems. - To simulate the auto pilot system using software.				
LIST OF EXPERIMENTS: - Design of Multi rotor UAV. - Testing and Selection of appropriate propulsion system for Multi rotor UAVs. - Integration, Testing and Calibration of Autopilot system in Multi rotor UAVs. - Control - PID Calibration of multi rotor flight controller. - Simulation of piloting of unmanned systems using flight simulator software. - Generation of 3D modeling using visual SFM and Mesh Lab. - Design and parameter calculation of fixed wing UAV.				
				TOTAL: 15 PERIODS
COURSE OUTCOMES: At the end of the course, the students will be able to CO1: Design and calculation of multi rotor UAV. CO2: Build and select suitable the propulsion system of UAV systems. CO3: Model the auto pilot system using flight controller software.				
REFERENCES: - Paul G Fahlstrom, Thomas J Gleason, Introduction to UAV Systems, 5th Edition, Wiley publications, 2022. - Dr. Armand J. Chaput, Design of Unmanned Air Vehicle Systems, 1st Edition, Lockheed Martin Aeronautics Company, 2001 - Kimion P. Valavanis, Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Springer, 2008				

21OCEC06	ARTIFICIAL NEURAL NETWORKS – A PRACTICAL APPROACH	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES: - To explore the architecture and learning principles of Neural Networks. - To develop the various hybrid algorithms involved in Neural Networks. - To provide adequate knowledge of application of Neural Networks to real time					

systems.

LIST OF EXPERIMENTS

1. Convolution Neural Network
2. Perceptron learning
3. Multi layer feed forward neural networks
4. Hopfield model for pattern storage task
5. Hopfield model with stochastic update
6. Optimization problems using Hopfield models
7. Mean-field annealing using ANN.

TOTAL: 15 PERIODS

COURSE OUTCOMES:

At the end of the course, the learners will be able to

CO1: Apply the concept of neural in practical applications.

CO2: Analyze the performance of advanced neural networks.

CO3: Solve real world problems using Neural Techniques.

REFERENCES:

1. Jang J.S.R., Sun C.T, MizutaniE, “Neuro Fuzzy and Soft computing”, Pearson education (Singapore), Reprint 2010.
2. S.Rajasekaran and G.A.Vijayalakshmi Pai “Neural networks, Fuzzy logics, and Genetic algorithms”, Prentice Hall of India, 2013.
3. J.A.Freeman, B.M.Skapura, "Neural Networks, Algorithms Applications and Programming Techniques", Addison–Wesly, 2003.
4. LaureneV.Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Prentice Hall, 2013.

21OCEC07	REMOTE SENSING IMAGE ANALYSIS USING ENVI PACKAGE	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: - To understand various components of remote sensing. - To provide an exposure to GIS and its practical applications - To understand the image pre-processing techniques in remote sensing.				
LIST OF EXPERIMENTS				
1. Image resizing and rotation. 2. Image Mosaicking using ENVI. 3. Image Segmentation – Multispectral images. 4. Supervised Classification for Multispectral images. 5. Supervised Classification for Hyperspectral Images. 6. Unsupervised Classification for Multispectral images. 7. Unsupervised Classification for Hyperspectral Images. 8. LANDSAT TM and SPOT data fusion. 9. Anomaly detection. 10. Principal Component Analysis.				
TOTAL: 15 PERIODS				
COURSE OUTCOMES: At the end of the course, the learners will be able to CO1: Apply the knowledge on Principles of Remote Sensing and GIS. CO2: Analyze and interpret the remote sensing data. CO3: Integrate GIS and Remote sensing data for specific applications.				
REFERENCES: - Lillesand,T.M, Kiefer,R.W and J.W.Chipman, “Remote Sensing and Image Interpretation” 5th Edition, John Willey and Sons Asia Pvt. Ltd., NewDelhi, 2011. - AnjiReddy.M. “Text book of Remote Sensing and Geographical Information System” 2nd Edition, BS Publications, Hyderabad, 2010.				

21OCEC08	ARDUINO FOR ENGINEERS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES: - To examine the hardware architecture of Arduino board. - To apply skills on programming and interfacing of peripheral devices with Arduino. - To utilize the Arduino board for practical applications.
LIST OF EXPERIMENTS - Study of Arduino and its types. - Arduino IDE for Blink LED - Programming. - RGB LED using Arduino - Programming. - Temperature monitoring using Arduino. - RFID, NFC using Arduino. - MQTT protocol using Arduino. - Zigbee Protocol using Arduino. - Design the circuit to interface LM35 with Arduino UNO controller. - Develop the embedded system to activate serial communication of Arduino UNO. - Interfacing of analog, digital and ultrasonic sensors with Arduino UNO.
MINI PROJECT-SYSTEM DESIGN WITH ARDUINO Digital Code Lock – Temperature Monitoring System – Automatic Light System – Ultrasonic Distance meter – Automatic Irrigation System – Home Automation – Line follower Robot – Room Cleaning Robot with ultrasonic sensors
TOTAL: 15 PERIODS
COURSE OUTCOMES: At the end of the course, the students will be able to CO1: Understand the hardware architecture of Arduino. CO2: Develop a program and interface the Arduino board with peripherals CO3: Design Arduino based practical real life applications.
REFERENCES: J. M. Hughes, “Arduino: A Technical Reference”, 1st Edition, O’Reilly Media, Inc, USA, 2016. - Richard Blum, “Arduino Programming in 24 Hours, Sams Teach Yourself”, 1st Edition, Pearson Education Inc, 2015.

21OCEC09	IOT FOR HEALTHCARE MONITORING	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES: - To understand the various standards of IoT. - To design a IoT model interfaced with sensors. - To understand the practical use cases of IoT in real time applications.					
LIST OF EXPERIMENTS: - Recording and Remote Monitoring of ECG in standard lead systems using IoT. - Recording and Remote Monitoring of Electromyogram signals using IoT . - Recording Remote Monitoring of EEG signal signals using IoT. - Measurement and Continuous Monitoring of respiratory parameters using Embedded IoT. - Measurement of Vital parameters using patient monitoring system and IoT					
CASE STUDY: - Wireless Patient Monitor system. - Wearable Fitness & Activity Monitor Unit. - Design of IOT based pulse oximeter. - Neo Natal Health Parameter Monitoring Batch.					
TOTAL: 15 PERIODS					
COURSE OUTCOMES: At the end of the course, the students will be able to CO1: Illustrate the basic concepts of IOT in healthcare. CO2: Relate the existing hardware platforms and sensor interfaces for various healthcare based applications. CO3: Build various applications in healthcare using IOT based approach and substantiate the same with appropriate case studies.					
REFERENCES: - Enrioco Coira , “Guide to healthcare informatics” , 2nd Edition, Arnold Publication, 2019. - Frank Sullivan, Jyreme C Watt, “ABC of Health Informatics”, ABC series, 2006. - Arshdeep Bahga, Vijay Madiseti, “Internet of Things-A hands-on approach”, Universities Press, 2015.					

21OCEC10	WEARABLE DEVICES FOR MEDICAL APPLICATIONS	L	T	P	C
		0	0	2	1
COURSE OBJECTIVES: • To identify the need for development of wearable devices and its implications on various sectors. • To comprehend the design and development of various wearable inertial sensors. • To explore the usage of various wearable locomotive sensors as assistive devices for tracking and navigation.					
LIST OF EXPERIMENTS: 1. Study of electrical activity of heart using wearable ECG system. 2. Study of electrical activity of muscles using wearable EMG system. 3. Study of electrical pattern of brains using wearable EEG system. 4 Study of blood pressure using wearable pressure sensors. 5. Study of respiration rate using accessories.					
6. Study of Galvanic Skin Resistance using wearable electrodes. 7. Study of body temperature using wearable temperature sensor.					
TOTAL: 15 PERIODS					
COURSE OUTCOMES: At the end of the course, the students will be able to CO1: Outline the need for development of wearable devices and its influence on Various sectors. CO2: Explain the applications of wearable inertial sensors for biomedical applications. CO3: Summarize the working principle of wearable assistive devices.					
REFERENCES: 1. Toshiyo Tamura and Wenxi Chen, "Seamless Healthcare Monitoring", Springer 2018. 2. Edward Sazonov and Michael R. Neuman, "Wearable Sensors-Fundamentals, Implementation and Applications", Elsevier Inc., 2014. 3. Aime Lay- Ekuakille and Subhas Chandra Mukhopadhyay, "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", Springer 2010.					

21OCEC11	DESIGN THINKING	L	T	P	C
		1	0	0	1
COURSE OBJECTIVES: - To outline the design thinking concepts and principles. - To use design thinking methods in every stage of the problem. - To apply various methods in design thinking.					
UNIT I	INTRODUCTION TO DESIGN THINKING				
Need for Design - Four Questions, Ten Tools - Principles of Design Thinking - The process of Design Thinking - How to plan a Design Thinking project.					
UNIT II	IDEATION AND PROTOTYPE				
Ideate Phase - The creative process and creative principles - Creativity techniques - Evaluation of ideas - Prototype Phase - Lean Startup Method for Prototype Development - Visualization and presentation techniques.					
UNIT III	TESTING AND IMPLEMENTATION				
Test Phase - Tips for interviews - Tips for surveys - Kano Model - Desirability Testing - How to conduct workshops - Requirements for the space - Material requirements - Agility for Design Thinking.					
TOTAL: 15 PERIODS					
COURSE OUTCOMES: At the end of the course, learners will be able to CO1: Illustrate the key concepts of design thinking. CO2: Outline design thinking in all stages of problem solving. CO3: Apply design thinking approach to real world problems.					
REFERENCES: 1. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011. 2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.					

3. Johnny Schneider, "Understanding Design Thinking, Lean and Agile", O'Reilly Media, 2017.
4. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.

21OCEC12	EMOTIONAL INTELLIGENCE	L	T	P	C
		1	0	0	1
COURSE OBJECTIVES: - To gain knowledge of emotional intelligence and its importance to personal and professional success. - To increase the level of emotional intelligence. - To employ the emotions for better decision making.					
UNIT I	CONCEPT OF EMOTIONAL INTELLIGENCE				
Emotion- Meaning, characteristics of emotion, components of emotion-cognitive component, physiological component, Behavioural component. Types of emotions, exposing the myths about emotion, physiological or bodily changes accompanying emotions. Development of emotions and emotional maturity, Emotional Intelligence – concept, history, measurement of EI.					
UNIT II	INTERPERSONAL AND INTRAPERSONAL AWARENESS				
Interpersonal Awareness Introduction, awareness about others-meaning and definition, awareness about others and success, personal life, professional life, development of awareness about others, empathy and reality testing. Interpersonal Management - Managing Interpersonal Relationships, Flexibility, Flexibility and success.					
UNIT III	CONFLICT MANAGEMENT AND LEADERSHIP				
Conflict Management, stages- pre-negotiation stage, negotiation stage, post negotiation stage, conflict management and success. Co-operation and collaboration, development of the skill of co-operation and collaboration Leadership- leadership – meaning and definition , leadership style and traits - task-oriented and relation oriented styles, authoritarian, democratic and laissez faire styles, Inspirational leadership.					
TOTAL: 15 PERIODS					
COURSE OUTCOMES:					

At the end of the course, learners will be able to

CO1: Summarize the characteristics and components of EI.

CO2: Interpret the problem solving methods in enhancing relationships.

CO3: Illustrate the techniques to enhance collaboration and leadership skills.

REFERENCES:

1. Harvard Business Review, Daniel Goleman, Richard E. Boyatzis, Sydney Finkelstein, Annie McKee, "HBR's 10 Must Reads on Emotional Intelligence", Harvard Business Review Press, 2015.
2. Chade-Meng Tan, Daniel Goleman, Jon Kabat-Zinn, "Search Inside Yourself", HarperCollins, 2012.
3. Daniel Goleman, "Emotional Intelligence Why It Can Matter More Than IQ", Bloomsbury Publishing, 2009
4. Liz Wilson, Stephen Neale & Lisa Spencer-Arnell, "Emotional Intelligence Coaching". Kogan Page India Private Limited, 2012

MANDATORY COURSES

21MCC01	CONSTITUTION OF INDIA	L	T	P	C
		1	0	0	0
COURSE OBJECTIVES: ● To explain the basic features and fundamental principles of Constitution of India. ● To explain the salient features and characteristics of the Constitution of India. ● To explain the Directive Principles of State Policy, Federal structure and distribution of legislative and financial powers. ● To explain the amendment of the Constitutional Powers and Procedure, the historical perspectives of the constitutional amendments in India. ● To explain the Local Self Government – Constitutional Scheme in India.					

SYLLABUS:

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States.
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India.
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

At the end of the course, learners will be able to:

CO1: Explain the meaning of the constitution law and constitutionalism and Historical perspective of the Constitution of India.

CO2: Explain the salient features and characteristics of the Constitution of India, scheme of the fundamental rights and the scheme of the Fundamental Duties and its legal status.

CO3: Explain the Directive Principles of State Policy, Federal structure and distribution of legislative and financial powers between the Union and the States, and Parliamentary Form of Government in India.

CO4: Explain the amendment of the Constitutional Powers and Procedure, the historical perspectives of the constitutional amendments in India, and Emergency Provisions.

CO5: Explain the Local Self Government – Constitutional Scheme in India, Scheme of the Fundamental Right to Equality.

TEXT BOOKS:

1. Durga Das Basu, "Introduction to the Constitution of India", LexisNexis Butterworths Wadhwa, 20th Edition, Reprint 2011.
2. Web link: [https://www.india.gov.in/my-government/ constitution-India](https://www.india.gov.in/my-government/constitution-India).

21MCC02	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
		1	0	0	0
COURSE OBJECTIVES: ● To explain the concept of Indian Traditional Knowledge along with Indian Modern Knowledge. ● To explain the need and importance of protecting Traditional Knowledge, Knowledge sharing, and Intellectual property rights over Traditional Knowledge. ● To explain about the use of Traditional Knowledge to meet the basic needs of human being. ● To explain the rich biodiversity materials and knowledge preserved for practicing traditional lifestyle. ● To explain the use of Traditional Knowledge in Manufacturing and Industry.					
UNIT-I	TRADITIONAL AND MODERN KNOWLEDGE				3
Two Worlds of Knowledge - Phase of Explorers, Sir Arthur Cotton and Irrigation, Smallpox Vaccination, Late Nineteenth Century, Voelcker, Howard and Agriculture, Havell and Indian Art; Indians at the Encounter - Gaekwad of Baroda and Technical Education, Science Education and Modern Industries, Hakim Ajmal Khan and Ayurveda, R. N. Chopra and Indigenous Drugs, Gauhar Jaan and Indian Classical Music; Linking Science and the Rural - Tagore’s Sriniketan Experiment, Marthandam, the YMCA Model, Gandhi’s Thoughts on Development, Nehru’s View of Growth; Post- Independence Era - Modernization and Traditional Knowledge, Social Roots of Traditional Knowledge Activism, Global Recognition for Traditional Knowledge.					
UNIT-II	PROTECTION AND SHARING				3

For Recognition and Protection - United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), International Labour Organization (ILO), UN Working Group on Indigenous Populations, Evolution of Other Organizations; Norms of Sharing - United Nations Environment Programme (UNEP), World Intellectual Property Organization (WIPO), World Trade Organization (WTO); IPR and Traditional Knowledge - Theoretical Background, Positive Protections of TK, Defensive Strategies, IPR Facilitation for TK.		
UNIT-III	TRADITIONAL KNOWLEDGE FOR BASIC NEEDS	3
Indian Midwifery Tradition—The Dai System, Surface Flow Irrigation Tanks, Housing - A Human Right, Changing Priorities—Niyamgiri. Biodiversity and Genetic Resources: Jeevani - The Wonder Herb of Kanis, A Holistic Approach - FRLHT, Basmati - In the New Millennium, AYUSH-Based Cosmetics.		
UNIT-IV	TRADITIONAL KNOWLEDGE IN MANUFACTURING	3
Drug Discovery, A Sweetener of Bengal, The Sacred Ring of Payyanur, Channapatna Toys.		
UNIT-V	TRADITIONAL CULTURAL EXPRESSIONS	3
Banarasi Saree, Music, Built and Tangible Heritage, Modern Yoga, Sanskrit and Artificial Intelligence, Climate Change and Traditional Knowledge.		
TOTAL : 15 PERIODS		
COURSE OUTCOMES: At the end of the course, learners will be able to: CO1: Explain the concept of Indian Traditional Knowledge along with Indian Modern knowledge. CO2: Explain the need and importance of protecting Traditional Knowledge, Knowledge sharing, and Intellectual property rights over Traditional Knowledge. CO3: Explain about the use of Traditional Knowledge to meet the basic needs of human being. CO4: Explain the rich biodiversity materials and knowledge preserved for practicing traditional lifestyle. CO5: Explain the use of Traditional Knowledge in Manufacturing and Industry.		

TEXT BOOKS:

1. Nirmal Sengupta “Traditional Knowledge in Modern India Preservation, Promotion, Ethical Access and Benefit Sharing Mechanisms” Springer, 2019.
2. Amit Jha,”Traditional Knowledge System in India”, Atlantic Publishers and Distributors Pvt Ltd, 2009.
3. Basanta Kumar Mohanta, Vipin Kumar Singh “Traditional Knowledge System and Technology in India”, Pratibha Prakashan, 2012.
4. Kapil Kapoor, Michel Danino "Knowledge Traditions and Practices of India", Central Board of Secondary Education, 2012.

WEB REFERENCES :

1. NPTEL video lecture on “Ayurvedic Inheritance of India”, Video link: <https://nptel.ac.in/courses/121/106/121106003/#>.
2. Youtube video on “Introduction to Indian Knowledge Systems”, Video link: <https://www.youtube.com/watch?v=LZP1StpYEPM>.
3. Youtube video on “12 Great achievements of Indian Civilization”, Video link: <https://www.youtube.com/watch?v=xmogKGCmclE>.

VERTICAL VI
HIGH SPEED COMMUNICATIONS

21PEC57	MOBILE COMMUNICATION	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES: - To summarize the basic concepts of mobile computing and various types of multiple access techniques. - To explain the basics of mobile telecommunication system. - To explore the characteristics of Wireless LAN, Bluetooth and Wi-Fi Technologies. - To interpret the network protocol stack. - To learn about transport and application layer.					
UNIT I	INTRODUCTION TO MOBILE COMMUNICATION	9			
Introduction to Mobile Computing, Applications of Mobile Computing, Generations of Mobile Communication Technologies, MAC Protocols, SDMA, TDMA, FDMA, CDMA. Comparison between the Multiple Access Techniques.					
UNIT II	MOBILE TELECOMMUNICATION SYSTEM	9			
GSM: Architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Mobility Management, Security, GPRS, UMTS, Architecture.					
UNIT III	WIRELESS NETWORKS	9			
Wireless LANs and PANs, IEEE 802.11 Standard, Architecture, Services, Bluetooth, Wi-Fi, WiMAX.					
UNIT IV	MOBILE NETWORK LAYER	9			
Mobile IP, DHCP, Ad-Hoc, Proactive and Reactive Routing Protocols, Multicast Routing, Vehicular Ad Hoc networks (VANET), MANET Vs VANET, Security Issues.					
UNIT V	MOBILE TRANSPORT AND APPLICATION LAYER	9			
Mobile TCP- Types of TCP, WAP, Architectures - WDP, WTLS, WTP, WSP, WAE, WTA Architecture, WML.					
TOTAL : 45 PERIODS					
COURSE OUTCOMES: At the end of this course, learners will be able to CO1: Illustrate the basics of mobile telecommunication system.					

CO2: Summarize the generations of telecommunication systems in wireless network.

CO3: Illustrate the architecture of wireless LAN technologies.

CO4: Interpret the functionality of network layer and identify a routing protocol for a given Ad-hoc networks.

CO5: Summarize the functionalities of Transport and Application layer.

TEXT BOOKS:

1. Jochen Schiller, “Mobile Communications”, 2nd Edition, PHI, 2009.
2. Prasant Kumar Pattnaik, Rajib Mall, “Fundamentals of Mobile Computing”, 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2016.
3. William. C. Y. Lee, “Mobile Cellular Telecommunications-Analog and Digital Systems”, 2nd Edition, Tata McGraw Hill Edition, 2017.

REFERENCES:

1. Dharma Prakash Agarwal and Qing-An Zeng, “Introduction to Wireless and Mobile systems”, 4th Edition, Cengage Learning, 2016.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of Mobile Computing”, 2nd Edition, Springer, 2006.
3. Gordon L. Stuber, “Principles of Mobile Communication”, Springer US, 2013.