Faculty of Electronics and Communication Engineering

B.E Electronics and Communication Engineering

Choice Based Credit Systems (CBCS)

Curriculum

Regulations R– 2022

I -VIII Semesters

B. E. ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS R-2022

CHOICE BASED CREDIT SYSTEM

I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To craft engineers with technical expertise in electronics & communication engineering with ethical practices to serve the society in a progressive manner.
2. To impart comprehensive knowledge in the design, analysis and implementation of electronic circuits, communication systems and other inter-related domains.
3. To elicit the passion for lifelong learning towards emerging technologies in the field of electronics & communication engineering for attaining excellence in career.
4. To augment the graduates to sustain in a multidisciplinary environment through exceptional individual, teamwork and leadership qualities.

II. PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

III. PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Developing a strong base in the fundamentals of Electronics and Communication Engineering thus enhancing problem solving skills needed to develop innovative and quality products for scientific applications.

PSO2: Implementing the functional blocks of modern hardware-software co-design, for applications of Signal Processing, Networking, Embedded Systems, VLSI, Wired and Wireless Communication through practical approaches.

PSO3: Applying multidisciplinary concepts to redefine problems and arrive at appropriate solutions, either independently or in team.

PSO4: Imparting social awareness, environmental wisdom, project management coupled with ethical responsibility to pursue a successful career and sustain the passion for real world applications.

Mapping of Programme Educational Objectives (PEOs) and the Program Outcomes (Pos):

PEOs	PROGRAMOUTCOMES(POS)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	2	2	2	2	3	3	3	2	3	2	3
PEO2	3	3	3	3	2	2	2	2	2	3	2	2
PEO3	3	3	3	3	3	3	3	2	2	3	2	3
PEO4	3	3	3	3	3	2	3	2	3	3	3	3

REGULATIONS R-2022
B. E. ELECTRONICS AND COMMUNICATION ENGINEERING CHOICE BASED CREDIT SYSTEM
CURRICULA FOR SEMESTERS I TO VIII
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	IP4151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS4101	Communicative English	HSMC	3	0	0	3	3
3.	MA4102	Engineering Mathematics-I	BSC	3	1	0	4	4
4.	PH4103	Engineering Physics	BSC	3	0	0	3	3
5.	CY4104	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE4105	Problem solving and Python Programming	ESC	3	0	0	3	3
7.	GE4106	Engineering Graphics	ESC	2	0	4	6	4
8	GE4151	Heritage Of Tamils (தமிழர் மரபு)	HSMC	1	0	0	1	1
PRACTICALS								
9.	GE4107	Python Programming Laboratory	ESC	0	0	4	4	2
10.	BS4108	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
TOTAL				**17**	**1**	**12**	**30**	**25**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	HS4201	Professional English	HSMC	3	0	0	3	3
2.	MA4202	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH4252	Physics for Electronics Engineering	BSC	3	0	0	3	3
4.	GE4204	Environmental Science and Engineering	BSC	3	0	0	3	3
5.	EE4205	Circuit Analysis	PCC	2	1	0	3	3
6.	EC4206	Electronic Devices	PCC	3	0	0	3	3
7	GE4251	Tamils and Technology (தமிழரும் தொழில்நுட்பம்)	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE4207	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	EC4208	Circuits and Devices Laboratory	PCC	0	0	4	4	2
TOTAL				**17**	**2**	**8**	**27**	**24**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	MA4352	Transforms and Complex Functions	BSC	3	1	0	4	4
2.	CS4353	Data Structures using C	ESC	3	0	0	3	3
3.	EC4303	Electronics Circuits and its Applications	PCC	3	0	0	3	3
4.	EC4304	Digital Circuits and Design	PCC	3	0	0	3	3
5.	EC4305	Control Systems Engineering	PCC	2	1	0	3	3
6.	EC4306	Electromagnetic Fields	PCC	3	0	0	3	3
PRACTICALS								
7.	EC4307	Analog and Digital Circuits Laboratory	PCC	0	0	4	4	2
8.	CS4358	Data Structures Laboratory	ESC	0	0	4	4	2
			TOTAL	**17**	**2**	**8**	**28**	**23**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	MA4401	Probability and Statistics	BSC	3	1	0	4	4
2.	EC4402	Signals and Systems	PCC	3	1	0	4	4
3.	EC4403	Communication systems	PCC	3	0	0	3	3
4.	EC4404	Linear Integrated Circuits	PCC	3	0	0	3	3
5.	EE4405	Sensors and Actuators	ESC	3	0	0	3	3
6.	EC4406	Transmission Lines and RF Systems	PCC	3	0	0	3	3
7.		Nan Mudhalvan						
PRACTICALS								
7.	EC4407	Communication Systems Laboratory	PCC	0	0	4	4	2
8.	EC4408	Linear Integrated Circuits Laboratory	PCC	0	0	4	4	2
9	HS4310	Professional Skills Development	EEC	0	0	2	2	1
			TOTAL	**18**	**2**	**10**	**30**	**25**

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SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	EC4501	Discrete Time Signal Processing	PCC	3	1	0	4	4
2.	EC4502	VLSI Design	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Mandatory Course-I[&]	MC	3	0	0	3	0
PRACTICALS								
7.	EC4508	VLSI Laboratory	PCC	0	0	4	4	2
8.	EC4509	Digital Signal Processing Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**1**	**8**	**27**	**20**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-I)

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	EC4651	Embedded Systems and IoT Design	PCC	3	0	0	3	3
2.	EC4602	Wireless Communication	PCC	3	0	0	3	3
3.		Open Elective – I**	OEC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Mandatory Course-II [&]	MC	3	0	0	3	0
		Nalayathiran	EEC					
PRACTICALS								
7.	EC4608	Embedded and IoT Laboratory	PCC	0	0	4	4	2
8.	EC4609	Mini Project	EEC	0	0	4	4	2
TOTAL				**18**	**0**	**8**	**26**	**19**

**** Open Elective I (Shall be chosen from the list of open electives offered by other programmes).**
[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-II)

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1.	GE4791	Human Values and Ethics	HSMC	3	0	0	3	3
2.	EC4702	Microwave and Optical Communication	PCC	3	0	0	3	3
3.	EC4703	Field and Service Robotics	PCC	3	0	0	3	3
4.		Open Elective – II**	OEC	3	0	0	3	3
5.		Open Elective – III**	OEC	3	0	0	3	3
6.		Elective Management[#]	HSMC	3	0	0	3	3
PRACTICALS								
7.	EC4706	Advanced Communication Laboratory	PCC	0	0	4	4	2
8.	EC4707	Robotics Laboratory	PCC	0	0	4	4	2
TOTAL				**18**	**0**	**8**	**26**	**22**

**** Open Elective II (Shall be chosen from the list of open electives offered by other Programmes).**
[#] Elective - Management shall be chosen from the Elective Management courses.

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective VI	PEC	3	0	0	3	3
2		Professional Elective VII	PEC	3	0	0	3	3
PRACTICALS								
3	EC4803	Project Work	EEC	0	0	20	20	10
			TOTAL	**6**	**0**	**20**	**26**	**16**

TOTAL CREDITS: 174

PROFESSIONAL ELECTIVE COURSES (PEC)

VERTICAL - I - SPACE TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4511	Radar Technologies	PEC	3	0	0	3	3
2.	EC4512	Basics of Avionics Systems	PEC	3	0	0	3	3
3.	EC4513	Positioning and Navigational Systems	PEC	3	0	0	3	3
4.	EC4514	Satellite Communication	PEC	3	0	0	3	3
5.	EC4515	Remote Sensing Techniques	PEC	3	0	0	3	3
6.	EC4516	Rocketry and Space Mechanics	PEC	3	0	0	3	3

VERTICAL- II - IC DESIGN and TESTING

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4521	Wide Bandgap Devices	PEC	3	0	0	3	3
2.	EC4522	RF ID System Design & Testing	PEC	3	0	0	3	3
3.	EC4523	Antenna Design Techniques	PEC	3	0	0	3	3
4.	EC4524	VLSI Testing and Design For Testability	PEC	3	0	0	3	3
5.	EC4525	FPGA based Embedded Design	PEC	3	0	0	3	3
6.	EC4526	Design of Analog IC	PEC	3	0	0	3	3

VERTICAL- III - BIOMEDICAL TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4531	Wearable Devices	PEC	3	0	0	3	3
2.	EC4532	Human Assist Devices	PEC	3	0	0	3	3
3.	EC4533	Therapeutic Equipment	PEC	3	0	0	3	3
4.	EC4534	Medical Imaging Systems	PEC	3	0	0	3	3
5.	EC4535	Brain Computer Interface and Applications	PEC	3	0	0	3	3
6.	EC4536	Body Area Networks	PEC	3	0	0	3	3

VERTICAL- IV - SIGNAL PROCESSING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4641	Advanced Digital Signal Processing	PEC	3	0	0	3	3
2.	EC4642	Image processing	PEC	3	0	0	3	3
3.	EC4643	Speech Processing	PEC	2	0	2	4	3
4.	EC4644	Software Defined Radio	PEC	2	0	2	4	3
5.	EC4645	DSP Architecture and Programming	PEC	2	0	2	4	3
6.	EC4646	Computer Vision for Robotics	PEC	2	0	2	4	3

VERTICAL - V – RF TECHNOLOGIES

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4651	RF Transceivers	PEC	3	0	0	3	3
2.	EC4652	Networks and Security	PEC	3	0	0	3	3
3.	EC4653	Low Power Integrated Circuit Design	PEC	3	0	0	3	3
4.	EC4654	MICs and RF System Design	PEC	3	0	0	3	3
5.	EC4655	EMI/EMC Pre compliance Testing	PEC	3	0	0	3	3
6.	EC4656	CAD for VLSI Circuits	PEC	3	0	0	3	3

VERTICAL-VI - HIGH SPEED COMMUNICATIONS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4861	Advanced Communication Technologies	PEC	3	0	0	3	3
2.	EC4862	Wireless Broadband Networks	PEC	3	0	0	3	3
3.	EC4863	Signal Integrity	PEC	3	0	0	3	3
4.	EC4864	Software Defined Networks	PEC	3	0	0	3	3
5.	EC4865	Millimeter Wave Communication	PEC	3	0	0	3	3
6.	EC4866	Photonic Networks	PEC	3	0	0	3	3

VERTICAL- VII - SENSOR TECHNOLOGIES and IoT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	EC4871	Adhoc Networks	PEC	3	0	0	3	3
2.	EC4872	IoT Based System Design	PEC	3	0	0	3	3
3.	EC4873	Wireless Sensor Networks	PEC	3	0	0	3	3
4.	EC4874	Industrial IoT and Industry 4.0	PEC	3	0	0	3	3
5.	EC4875	MEMS Design	PEC	3	0	0	3	3
6.	EC4876	Fundamentals of Nano electronics	PEC	3	0	0	3	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	OMA411	Graph Theory & its applications	OEC	3	0	0	3	3
2.	OEE411	Renewable Energy System	OEC	3	0	0	3	3
3.	OEC412	Foundation of Robotics	OEC	3	0	0	3	3
4.	OMB413	Digital Marketing	OEC	3	0	0	3	3
5.	OAD414	Artificial Intelligence and Machine Learning	OEC	3	0	0	3	3
6.	OMA426	Resource Management Techniques	OEC	3	0	0	3	3
7.	OME417	Introduction to Industrial Engineering	OEC	3	0	0	3	3

OPEN ELECTIVES – II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	OEE421	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
2.	OIT421	Dev-ops	OEC	3	0	0	3	3
3.	OAD422	R Programming for Data Science	OEC	3	0	0	3	3
4.	OEE423	Advanced Control Systems	OEC	3	0	0	3	3
5.	OMB443	Fintech Technologies	OEC	3	0	0	3	3
6	OME424	Sustainable Manufacturing	OEC	3	0	0	3	3
7.	OEC414	Biomedical Instrumentation	OEC	3	0	0	3	3

OPEN ELECTIVES – III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	OIT411	Fundamentals of Database Design	OEC	3	0	0	3	3
2.	OMA421	Algebra and Number Theory	OEC	3	0	0	3	3
3.	OAD432	Deep Learning	OEC	3	0	0	3	3
4.	OMB432	Operations Research	OEC	3	0	0	3	3
5.	OME427	Reverse Engineering	OEC	3	0	0	3	3
6.	OME429	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3

ELECTIVE – MANAGEMENT COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	MB4751	Principles of Management	HSMC	3	0	0	3	3
2.	MB4741	Total Quality Management	HSMC	3	0	0	3	3
3.	MB4043	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	MB4202	Human Resource Management	HSMC	3	0	0	3	3
5.	MB4044	Knowledge Management	HSMC	3	0	0	3	3
6.	GE4792	Industrial Management	HSMC	3	0	0	3	3

MANDATORY COURSES- I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	MX4001	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX 4002	Elements of Literature	MC	3	0	0	3	0
3.	MX 4003	Personality Development through Life Enlightenment Skills	MC	3	0	0	3	0
4.	MX 4004	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	HOURS PER WEEK			TOTAL CONTACT HOURS	CREDITS
				L	T	P		
1.	MX 4005	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX 4006	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX 4007	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX 4008	Industrial Safety	MC	3	0	0	3	0

SUMMARY OF CURRICULUM

S.No.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL	Percentage (%)
		I	II	III	IV	V	VI	VII	VIII		
1.	**HSMC**	**4**	**4**	**-**	**-**	**-**	**-**	**6**	**-**	**14**	**8.05**
2.	**BSC**	**12**	**10**	**4**	**4**	**-**	**-**	**-**	**-**	**30**	**17.24**
3.	**ESC**	**9**	**2**	**5**	**3**	**-**	**-**	**-**	**-**	**19**	**11.11**
4.	**PCC**	**-**	**8**	**14**	**17**	**11**	**8**	**10**	**-**	**68**	**39.08**
5.	**PEC**	**-**	**-**	**-**	**-**	**9**	**6**	**-**	**6**	**21**	**12.07**
6.	**OEC**	**-**	**-**	**-**	**-**	**-**	**3**	**6**	**-**	**09**	**5.17**
7.	**EEC**	**-**	**-**	**-**	**1**	**-**	**2**	**-**	**10**	**13**	**7.47**
TOTAL		**25**	**24**	**23**	**25**	**20**	**19**	**22**	**16**	**174**	**100**

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Space Technologies	Vertical II IC Design and Testing	Vertical III BioMedical Technologies	Vertical IV Signal Processing	Vertical VI RF Technologies	Vertical VI High Speed Communications	Vertical VII Sensor Technologies and IoT
Radar Technologies	Design of Analog IC	Wearable Devices	Advanced Digital Signal Processing	RF Transceivers	Advanced Communication Technologies	Adhoc Networks
Basics of Avionics Systems	Low Power Integrated Circuit Design	Human Assist Devices	Image processing	Networks and Security	Wireless Broad Band Networks	IoT Based System Design
Positioning and Navigational Systems	Antenna Design Techniques	Therapeutic Equipment	Speech Processing	RF ID System Design & Testing	Signal Integrity	Industrial IoT and Industry 4.0
Remote Sensing Techniques	VLSI Testing and Design For Testability	Medical Imaging Systems	Software Defined Radio	MICs and RF System Design	Software Defined Networks	Wireless Sensor Network Design
Satellite Communication	Design Testing of Mixed Signal IC	Brain Computer Interface and	DSP Architecture and	EMI/EMC Pre compliance Testing	Millimeter Wave Communication	MEMS Design
Rocketry and Space Mechanics	Wide Bandgap Devices	Body Area Networks	Computer Vision for Robotics	CAD for VLSI Circuits	Photonic Networks	Fundamentals of Nano electronics

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V,VI and VIII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2022.

SEMESTER I

HS4101	COMMUNICATIVE ENGLISH	L	T	P	C
	Common for all Branches of B.E. / B. Tech Programmes	3	0	0	3

OBJECTIVES

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills.

UNIT I	SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS	9
Reading — critical reading — finding key information in a given text — shifting facts from opinions - Writing - autobiographical writing - developing hints. Listening- short texts- short formal and informal conversations. Speaking- basics in speaking - introducing oneself - exchanging personal information- speaking on given topics & situations Language development– voices- Wh- Questions- asking and answering-yes or no questions– parts of speech. Vocabulary development-- prefixes- suffixes- articles - Polite Expressions.		**CO1**

UNIT II	GENERAL READING AND FREE WRITING	9
Reading: Short narratives and descriptions from newspapers (including dialogues and conversations; Reading Comprehension Texts with varied question types - Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –. Listening - long texts - TED talks - extensive speech on current affairs and discussions Speaking — describing a simple process — asking and answering questions - Language development – prepositions, clauses. Vocabulary development- guessing meanings of words in context – useofsequence words.		**CO2**

UNIT III	GRAMMAR AND LANGUAGE DEVELOPMENT	9
Reading- short texts and longer passages (close reading) & making a critical analysis of the given text Writing — types of paragraph and writing essays — rearrangement of jumbled sentences. Listening: Listening to ted talks and long speeches for comprehension. Speaking- role plays - asking about routine actions and expressing opinions. Language development- degrees of comparison- pronouns- Direct vs. Indirect Questions. Vocabulary development – idioms and phrases- cause & effect expressions, adverbs.		**CO3**

UNIT IV	READING AND LANGUAGE DEVELOPMENT	9
Reading- comprehension-reading longer texts- reading different types of texts- magazines. Writing- letter writing, informal or personal letters-e-mails-conventions of personal email- Listening: Listening comprehension (IELTS, TOEFL and others). Speaking -Speaking about friends/places/hobbies - Language development- Tenses- simple present-simple past- present continuous and past continuous- conditionals — if, unless, in case, when and others, Vocabulary development- synonyms-antonyms- Single word substitutes- Collocations.		**CO4**

UNIT V	EXTENDED WRITING	9
Reading: Reading for comparisons and contrast and other deeper levels of meaning –Writing- brainstorming -writing short essays — developing an outline- identifying main and subordinate ideas- dialogue writing- Listening - popular speeches and presentations - Speaking - impromptu speeches & debates Language development-modal verbs- present/ past perfect tense - Vocabulary development-Phrasal verbs- fixed and semi-fixed expressions.		**CO5**

TOTAL : 45 HOURS

TEXT BOOKS

1. Board of Editors. Using English, A Course book for Undergraduate Engineers andTechnologists. Orient Black Swan Limited, Hyderabad: 2020
2. Sanjay Kumar & Pushp Lata Communication Skills Second Edition, Oxford University Press:2015.
3. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCE BOOKS

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge,2011. Means, L. Thomas and Elaine Langlois. English & Communication For Colleges. CengageLearning ,USA: 2007
2. Redston, Chris &Gillies Cunningham Face 2 Face (Pre-intermediate Student s Book& Workbook) Cambridge University Press, New Delhi: 2005
3. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
4. Dutt P. Kiranmai and Rajeevan Geeta Basic Communication Skills, Foundation Books: 2013
5. John Eastwood et al : Be Grammar Ready: The Ultimate Guide to English Grammar, Oxford University Press: 2020.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
CO2	Write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
CO3	Read different genres of texts adopting various reading strategies.
CO4	Listen/view and comprehend different spoken discourses/excerpts in different accents
CO5	Identify topics and formulate questions for productive inquiry

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	-	-	-	2	3	-	-	2	-	1	1
CO2	-	1	-	2	-	-	-	-	-	3	-	-	2	-	2	1
CO3	-	2	-	3	-	-	-	-	-	2	-	-	1	-	2	1
CO4	-	-	-	-	-	-	-	-	2	2	-	-	1	-	2	1
CO5	-	2	1	1	2	-	2	-	-	3	-	-	2	-	1	1

MA4102	**ENGINEERING MATHEMATICS – I**	**L**	**T**	**P**	**C**
	(Common for all branches of B.E. / B. Tech Programmes)	3	1	0	4

OBJECTIVES

- ❖ To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- ❖ To familiarize the students with differential calculus.
- ❖ To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- ❖ To make the students understand various techniques of integration.
- ❖ To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I	**MATRICES**	**12**
Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms		**CO1**
UNIT II	**CALCULUS OF ONE VARIABLE**	**12**
Limit of a function - Continuity - Derivatives - Differentiation rules – Interval of increasing and decreasing functions – Maxima and Minima - Intervals of concavity and convexity.		**CO2**
UNIT III	**CALCULUS 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 – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.		**CO3**
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.		**CO4**
UNIT V	**MULTIPLE INTEGRALS**	**12**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Change of variables from Cartesian to polar in double integrals-Triple integrals – Volume of solids		**CO5**
		TOTAL : 60 HOURS

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 7th Edition, New Delhi,2015. [For Units I & III - Sections 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.2 - 7.4 and 7.8].

REFERENCE BOOKS

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. T. Veerarajan, “Engineering Mathematics – I”, McGraw Hill Education; First edition 2017.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Use the matrix algebra methods for solving practical problems
CO2	Apply differential calculus tools in solving various application problems.
CO3	Able to use differential calculus ideas on several variable functions.
CO4	Apply different methods of integration in solving practical problems.
CO5	Apply multiple integral ideas in solving areas, volumes and other practical problems.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO 7**	**PO8**	**PO 9**	**PO1 0**	**PO 11**	**PO1 2**	**PS O1**	**PSO2**	**PS O3**	**PSO4**
CO1	3	3	3	1	2	3	-	-	3	2	3	3	3	2	1	1
CO2	3	3	3	2	2	1	-	-	-	-	1	2	2	1	2	1
CO3	3	3	3	2	2	1	-	-	-	-	1	2	2	1	1	1
CO4	3	3	3	2	2	1	-	-	-	-	1	2	2	2	2	1
CO5	3	3	3	2	1	1	-	-	-	-	1	2	2	1	1	1

PH4103	**ENGINEERING PHYSICS**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	3	0	0	3

OBJECTIVES

- To make the students understand the elastic property and stress strain diagram.
- To educate the students about principle of laser and its role in optical fibers and its applicationsas sensors and communication.
- To teach the students about the heat transfer through solids and liquids.
- To educate the students about the quantum concepts and its use to explain black body radiation, Compton effect, tunnelling electron microscopy and its applications.
- To make the students to understand the importance of various crystal structures and various growth techniques.

UNIT I	PROPERTIES OF MATTER	9
Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment – Practical applications of modulus of elasticity-I-shaped girders - stress due to bending in beams.		**CO1**
UNIT II	**LASER AND FIBER OPTICS**	**9**
Lasers : population of energy levels, Einstein's A and B coefficients derivation — resonant cavity, optical amplification (qualitative) – Nd-YAG Laser-Semiconductor lasers: homojunction and heterojunction — Industrial and medical applications of Laser– Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) — losses associated with optical fibers — Fabrication of Optical fiber-Double crucible method-fibre optic sensors: pressure and displacement-Industrial and medical applications of optical fiber- Endoscopy-Fiber optic communication system.		**CO2**
UNIT III	**THERMAL PHYSICS**	**9**
Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity –Rectilinear flow of heat- Lee's disc method: theory and experiment - conduction through compound media (series and parallel)-Radial flow of heat– thermal insulation – applications: heat exchangers, refrigerators, oven, Induction furnace and solar water heaters.		**CO3**
UNIT IV	**QUANTUM PHYSICS**	**9**
Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – Electron microscope-tunnelling (qualitative) - scanning tunnelling microscope-Applications of electron microscopy.		**CO4**
UNIT V	**CRYSTAL PHYSICS**	**9**
Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices — inter-planar distances coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures — Graphite structure-crystal imperfections: point defects, line defects — Burger vectors, stacking faults – growth of single crystals: solution and melt growth techniques- Epitaxial growth-Applications of Single crystal (Qualitative).		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2019.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2017.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2019.

REFERENCE BOOKS

1. Halliday, D., Resnick, R. & Walker, J. "Engineering Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2019.
3. Tipler, P.A. & Mosca, G. 'Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Gain knowledge on the basics of properties of matter and its applications,
CO2	Acquire knowledge on the concepts of waves and optical devices and their applications in fiber optics.
CO3	Have adequate knowledge on the concepts of thermal properties of materials and theirapplications in expansion joints and heat exchangers.
CO4	Get knowledge on advanced physics concepts of quantum theory and its applications intunneling microscopes, and
CO5	Understand the basics of crystals, their structures and different crystal growth techniques.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**	**PSO 4**
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**1**	**2**	**3**	**1**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**3**
CO3	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**1**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**1**	**3**	**3**

CY4104	**ENGINEERING CHEMISTRY**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	3	0	0	3

OBJECTIVES

- Principles of water characterization and treatment for industrial purposes.
- Principles and applications of surface chemistry and catalysis.
- Phase rule and various types of alloys.
- Various types of fuels, applications and combustion.
- Conventional and non–conventional energy sources and energy storage device.

UNIT I	**WATER AND ITS TREATMENT**	**9**
Hardness of water – Types – Expression of hardness – Units – Estimation of hardness by EDTA method – Numerical problems on EDTA method – Boiler troubles (scale and sludge, caustic embrittlement, boiler corrosion, priming and foaming) – Treatment of boiler feed water – Internal treatment (carbonate, phosphate, colloidal, sodium aluminate and calgon conditioning) – External treatment – Ion exchange process, Zeolite process – Desalination of brackish water by reverse Osmosis.		**CO1**
UNIT II	**SURFACE CHEMISTRY AND CATALYSIS**	**9**
Surface chemistry: Types of adsorption – Adsorption of gases on solids – Adsorption of solute		

from solutions – Adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm — Kinetics of uni-molecular surface reactions — Adsorption in chromatography – Applications of adsorption in pollution abatement using PAC. **Catalysis**: Catalyst – Types of catalysis – Criteria – Contact theory – Catalytic poisoning and catalytic promoters – Industrial applications of catalysts – Catalytic convertor – Auto catalysis –Enzyme catalysis – Michaelis-Menten equation.		**CO2**
UNIT III	**PHASE RULE AND ALLOYS**	**9**
Phase rule: Introduction – Definition of terms with examples – One component system – Water system – Reduced phase rule – Thermal analysis and cooling curves – Two component systems – Lead-silver system – Pattinson process. **Alloys**: Introduction – Definition – Properties of alloys – Significance of alloying – Functions and effect of alloying elements – Nichrome, Alnico, Stainless steel (18/8) – Heat treatment of steel – Non-ferrous alloys – Brass and bronze.		**CO3**
UNIT IV	**FUELS AND COMBUSTION**	**9**
Fuels: Introduction – classification of fuels – Comparison of solid, liquid, gaseous fuels – Coal – Analysis of coal (proximate and ultimate). – Carbonization – Manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum – Cracking – Manufacture of synthetic petrol (Bergius process, Fischer Tropsch Process) — Knocking — Octane number — Diesel oil — Cetane number – Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – 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 by Orsat Method.		**CO4**
UNIT V	**NON–CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES**	**9**
Nuclear energy – Fission and fusion reactions – Differences – Chain reactions – Nuclear reactors – Classification of reactors – Light water nuclear reactor for power generation – Breeder reactor — Solar energy conversion — Solar cells — Wind energy — Fuel cells — Hydrogen-oxygen fuel cell . Batteries – Types of batteries - Alkaline batteries – Lead-acid, Nickel-cadmium and Lithium batteries.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. P.C.Jain, Monica Jain, "Engineering Chemistry" 17th Ed. Dhanpat Rai Pub. Co., New Delhi,(2015).
2. S.S. Dara, S.S. Umare, "A text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi(2020).
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India (P) Ltd. NewDelhi, (2018).
4. P. Kannan, A. Ravikrishnan, "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company (P) Ltd. Chennai, (2009).

REFERENCE BOOKS

1. B.K.Sharma "Engineering chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. B. Sivasankar "Engineering chemistry" Tata McGraw–Hill Pub.Co.Ltd, New Delhi (2008).
3. Prasanta Rath"Engineering chemistry" Cengage Learning India (P) Ltd., Delhi, (2015).
4. Shikha Agarwal, "Engineering Chemistry–Fundamentals and Applications", Cambridge University Press, Delhi, (2015).
5. A. Pahari, B. Chauhan, "Engineering chemistry", Firewall Media., New Delhi., (2010).
6. Sheik Mideen., Engineering Chemistry, Airwalk Publications, Chennai (2018).

COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Able to understand impurities in industrial water, boiler troubles, internal and external treatment methods of purifying water.
CO2	Able to understand concepts of absorption, adsorption, adsorption isotherms, application of adsorption for pollution abatement, catalysis and enzyme kinetics.
CO3	Able to recognize significance of alloying, functions of alloying elements and types of alloys, uses of alloys. They should be acquainted with phase rule and reduced phase and its applications in alloying.
CO4	Able to identify various types of fuels, properties, uses and analysis of fuels. They should beable to understand combustion of fuels, method of preparation of bio-diesel, synthetic petrol.
CO5	Able to understand conventional, non–conventional energy sources, nuclear fission and fusion, power generation by nuclear reactor, wind, solar energy and preparation, uses of various batteries.

	MAPPING OF COs WITH POs AND PSOs															
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PS O2**	**PSO3**	**PS O4**
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**1**	**2**	**1**
CO5	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**1**

GE4105	**PROBLEM SOLVING AND PYTHON PROGRAMMING**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	3	0	0	3

OBJECTIVES

- To know the basics of algorithmic problem solving
- To write simple python programs
- To develop python program by using control structures and functions
- To use python predefined data structures
- To write file-based program

UNIT I	**ALGORITHMIC PROBLEM SOLVING**	**9**
Algorithms, Building blocks of algorithms: statements, state, control flow, functions, Notation: pseudo code, flow chart, programming language, Algorithmic problem solving: Basic algorithms, flowcharts and pseudocode for sequential, decision processing and iterative processing strategies, Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.		**CO1**
UNIT II	**INTRODUCTION TO PYTHON**	**9**

Python Introduction, Technical Strength of Python, Python interpreter and interactive mode, Introduction to colab , pycharm and jupyter idle(s) ,Values and types: int, float, boolean, string, and list; Built-in data types, variables, Literals, Constants, statements, Operators: Assignment, Arithmetic, Relational, Logical, Bitwise operators and their precedence, Expressions, tuple assignment, Accepting input from Console, printing statements, Simple Python programs.		**CO2**
UNIT III	**CONTROL FLOW, FUNCTIONS AND STRINGS**	**9**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: while, for; Loop manipulation using pass, break, continue, and else; Modules and Functions: function definition and use, flow of execution, parameters and arguments, local and global scope, return values, function composition, recursion. Strings: string slices, immutability, string functions and methods, string module; Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.		**CO3**
UNIT IV	**LISTS, TUPLES, DICTIONARIES**	**9**
Lists: Defining list and list slicing, list operations, list slices, list methods, list loop, list Manipulation, mutability, aliasing, cloning lists, list parameters, lists as arrays. Tuples: tuple assignment, tuple as return value, tuple Manipulation; Dictionaries: operations and methods; advanced list processing — list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.		**CO4**
UNIT V	**FILES, MODULES, PACKAGES**	**9**
Files and exception: Concept of Files, Text Files; File opening in various modes and closing of a file, Format Operators, Reading from a file, Writing onto a file, File functions- open(), close(), read(),readline(), readlines(),write(), writelines(),tell(),seek(), Command Line arguments; Errors and exceptions: handling exceptions; modules, packages; introduction to numpy, matplotlib. Illustrative programs: word count, copy a file.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist ", 2nd edition, Updated for Python 3, Shroff/O Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, - An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford University Press, 2019.

REFERENCE BOOKS

1. John V Guttag, ——Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, —Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
4. Kenneth A. Lambert, —Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, —Practical Programming: An Introduction.

COURSE OUTCOMES **Upon completion of the course, students will be able to**	
CO1	Develop algorithmic solutions to simple computational problems
CO2	Develop simple console application in python
CO3	Develop python program by applying control structure and decompose program into functions.
CO4	Represent compound data using python lists, tuples, and dictionaries.
CO5	Read and write data from/to files in Python.

MAPPING OF COs WITH POs AND PSOs																
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**1**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**1**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**1**	**3**	**1**
CO5	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**1**	**3**	**1**

GE4106	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	2	0	4	4

OBJECTIVES

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)	**1**
Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering anddimensioning.	
UNIT I **PLANE CURVES AND FREEHAND SKETCHING**	**7+12**
Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle – Drawing of tangents and normal to the above curves. 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	**CO1**
UNIT II **PROJECTION OF POINTS, LINES AND PLANE SURFACE**	**6+12**
Orthographic projection- principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.	**CO2**
UNIT III **PROJECTION OF SOLIDS**	**5+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.	**CO3**
UNIT IV **PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**	**6+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.		**CO4**
UNIT V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**6+12**
Principles of isometric projection — isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		**CO5**
		TOTAL : 90 HOURS

TEXT BOOKS

1. Natarajan K.V., ―A text book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, Twenty Ninth Edition 2016
2. Venugopal K. and Prabhu Raja V., ―Engineering Graphics‖, New Age International (P) Limited,2011.

REFERENCE BOOKS

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2018.
4. Luzzader, Warren.J. and Duff,John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Comput er Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, "Engineering Graphic", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Understand the fundamentals and standards of Engineering graphics
CO2	Perform freehand sketching of basic geometrical constructions and multiple views of objects
CO3	Understand the concept of orthographic projections of lines and plane surfaces
CO4	Draw the projections of section of solids and development of surfaces
CO5	Visualize and to project isometric and perspective sections of simple solids

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)												PROGRAM SPECIFIC OUTCOMES (PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	3	3	-	-	-	-	3	3	3	-	-	-	-	3
CO2	-	3	3	3	-	-	-	-	3	3	3	-	-	-	-	3
CO3	-	3	3	3	-	-	-	-	3	3	3	-	-	-	-	3
CO4	-	3	3	3	-	-	-	-	3	3	3	-	-	-	-	3
CO5	-	3	3	3	-	-	-	-	3	3	3	-	-	-	-	3

GE4151	HERITAGE OF TAMILS	L	T	P	C
	Common for all branches of B.E. / B. Tech Programmes	1	0	0	1

UNIT I	LANGUAGE AND LITERATURE	3
Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.		CO1
UNIT II	**HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**	**3**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.		CO2
UNIT III	**FOLK AND MARTIAL ARTS**	**3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari,Tiger dance - Sports and Games of Tamils.		CO3
UNIT IV	**THINAI CONCEPT OF TAMILS**	**3**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.		CO4
UNIT V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other partsof India — Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine — Inscriptions & Manuscripts — Print History of Tamil Books.		CO5
		TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

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

GE4151	**தமிழர் மரபு**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	1	0	0	1

அலகு I	**மொழி மற்றும் இலக்கியம்**	**3**
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் மற்றும் தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம் alwargal மற்றும் நாயன்மார்கள் - சிறுகவிதை வடிவங்கள் - தமிழில் இலக்கிய வளர்ச்சி பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		**CO1**
அலகு II	மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை	**3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை- ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள்- தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை இசை கருவிகள் மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம்- தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		**CO2**
அலகு III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்	**3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல் பாவை கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம் - தமிழர்களின் விளையாட்டுகள்.		**CO3**
அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்	**3**
தமிழர்கள் போற்றிய அறக்கோட்பாடுகள் , சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும் சங்ககால நகரங்களும் துறை முகங்களும் சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி கடல்கடந்த நாடுகளின் சோழர்களின் வெற்றி.		**CO4**
அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்கு தமிழர்களின் பங்களிப்பு	**3**
இந்திய விடுதலை போராட்டத்தில் தமிழர்களின் பங்களிப்பு - இந்தியாவின் பிற பகுதிகளில் தமிழ் பயன்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவ முறைகளில் சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள் மற்றும் கையெழுத்துப்படிகள் - தமிழ் புத்தகங்களின் அச்சு வரலாறு.		**CO5**
		TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

GE4107	PYTHON PROGRAMMING LABORATORY	L	T	P	C
	Common for all branches of B.E. / B. Tech Programmes	0	0	4	2

OBJECTIVES

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, and dictionaries.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS

1. Write an algorithm and draw flowchart illustrating mail merge concept.	**CO1**
2. Write an algorithm, draw flowchart and write pseudo code for a real life or scientific or technical problems	
3. Scientific problem-solving using decision making and looping. • Armstrong number, palindrome of a number, Perfect number.	
4. Simple programming for one dimensional and two-dimensional arrays. • Transpose, addition, multiplication, scalar, determinant of a matrix	
5. Program to explore string functions and recursive functions.	**CO2**
6. Utilizing ‗Functions' in Python • Find mean, median, mode for the given set of numbers in a list. • Write a function dups to find all duplicates in the list. • Write a function unique to find all the unique elements of a list. • Write function to compute gcd, lcm of two numbers.	
7. Demonstrate the use of Dictionaries and tuples with sample programs.	
8. Implement Searching Operations: Linear and Binary Search.	
9. To sort the ‗n' numbers using: Selection, Merge sort and Insertion Sort.	
10. Find the most frequent words in a text of file using command line arguments.	**CO3**
11. Demonstrate Exceptions in Python.	
12. Applications**:** Implementing GUI using turtle, pygame.	
TOTAL: 60 HOURS	

REFERENCE BOOKS

1. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford UniversityPress, 2019
2. Allen B. Downey , ― Think Python: How to Think Like a Computer Scientist‖, Second Edition,Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
3. Shroff ―Learning Python: Powerful Object-Oriented Programming; Fifth edition, 2013.
4. David M.Baezly ―Python Essential Reference‖. Addison-Wesley Professional; Fourth edition, 2009.
5. David M. Baezly ―Python Cookbook‖ O'Reilly Media; Third edition (June 1, 2013)

WEB REFERENCES

1. http://www.edx.org

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Develop simple console applications through python with control structure and functions

CO2	Use python built in data structures like lists, tuples, and dictionaries for representing compound data.
CO3	Read and write data from/to files in Python and applications of python.

MAPPING OF COs WITH POs AND PSOs																
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	3	3	2	-	-	-	-	2	2	2	2	2	2	2
CO2	3	3	3	3	2	-	-	-	-	2	2	2	2	2	2	2
CO3	3	3	3	3	2	-	-	-	-	2	2	2	1	1	1	2

BS4108	**PHYSICS AND CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	0	0	4	2

OBJECTIVES

The students will be trained to perform experiments to study the following.

- ❖ The Properties of Matter
- ❖ The Optical properties, Characteristics of Lasers & Optical Fibre
- ❖ Electrical & Thermal properties of Materials
- ❖ Enable the students to enhance accuracy in experimental measurements.
- ❖ To make the student to acquire practical skills in the determination of water quality parameters through volumetric analysis
- ❖ Instrumental method of analysis such as potentiometry, conductometry and pHmetry

LIST OF EXPERIMENTS – PHYSICS

(A minimum of 5 experiments to be performed from the given list)

1. Determination of Young's modulus of the material of the given beam by Non-uniform bending method.	**CO1**
2. Determination of Young's modulus of the material of the given beam by uniform bending method.	
3. Determination of rigidity modulus of the material of the given wire using torsion pendulum.	
4. Determination of wavelength of mercury spectra using Spectrometer and grating.	**CO2**
5. Determination of dispersive power of prism using Spectrometer.	
6. (a) Determination of wavelength and particle size using a laser. (b) Determination of Numerical and acceptance angle of an optical fibre.	
7. Determination of energy band gap of the semiconductor.	
8. Determination of coefficient of thermal conductivity of the given bad conductor using Lee's disc.	

DEMONSTRATION EXPERIMENT

1. Determination of thickness of a thin sheet / wire – Air wedge method	**CO1**

LIST OF EXPERIMENTS – CHEMISTRY

(A minimum of 6 experiments to be performed from the given list)

1. Determination of chloride content of water sample by argentometric method.	**CO3**
2. Estimation of copper content of the given solution by Iodometry.	
3. Determination of strength of given hydrochloric acid using pH meter.	

4. Determination of strength of acids in a mixture of acids using conductivity meter.	**CO4**
5. Estimation of iron content of the given solution using potentiometer.	
6. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.	
7. Conductometric titration of strong acid vs strong base.	
8. Estimation of HCl using Na_2CO_3 as primary standard and determination of alkalinity in water sample.	**CO5**
9. Determination of total, temporary & permanent hardness of water by EDTA method.	
10. Determination of DO content of water sample by Winkler's method.	
DEMONSTRATION EXPERIMENTS	
1. Estimation of iron content of the water sample using spectrophotometer (1,10-Phenanthroline / thiocyanate method).	**CO3**
2. Estimation of sodium and potassium present in water using flame photometer.	**CO5**
TOTAL: 60 HOURS	

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Able to understand the concept about the basic properties of matter like stress, strain and types of moduli Able to understand the concept of optics like reflection, refraction, diffraction by using spectrometer grating.
CO2	Able to understand the thermal properties of solids, specific heat and some models for specificheat calculation. Able to understand the working principle of laser components and working of different laser system. Able to understand the phenomenon of light, applications of fibre optics.
CO3	Able to understand the concept of determining the pH value by using pH meter. Able to understand the concept about the amount of chloride present in the given sample ofwater.
CO4	Able to understand the concept of determining the emf values by using potentiometer Able to understand the concept about the measurement of conductance of strong acid andstrong base by using conductivity meter.
CO5	Able to understand the amount of dissolved oxygen present in the water. Able to understand the concept of estimation of hardness of water by EDTA method. Able to understand the concept of estimation of alkalinity in water sample.

	MAPPING OF COs WITH POs AND PSOs															
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO1 1**	**PO 12**	**PSO 1**	**PS O2**	**PS O3**	**PSO 4**
CO1	**3**	**1**	**2**	**2**	**2**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**
CO2	**3**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**1**
CO3	**3**	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**-**	**1**	**1**
CO4	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**-**	**1**	**2**
CO5	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**-**	**1**	**2**

SEMESTER II

HS4201	PROFESSIONAL ENGLISH	L	T	P	C
	(Common to all branches of B.E. / B. Tech. Programmes)	3	0	0	3

OBJECTIVES

- ❖ To engage learners in meaningful language activities to improve their LSRW skills
- ❖ To enhance learners' awareness of general rules of writing for specific audiences
- ❖ To help learners understand the purpose, audience, contexts of different types of writing
- ❖ To develop analytical thinking skills for problem solving in communicative contexts
- ❖ To demonstrate an understanding of job applications and interviews for internship and placements

UNIT I	MAKING COMPARISONS	9
Listening – Evaluative Listening: Advertisements, Product Descriptions, -Audio / video; Listening and filling a Graphic Organiser (Choosing a product or service by comparison) Speaking – Marketing a product, Persuasive Speech Techniques. Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay - Writing definitions; Grammar –Prepositional phrases. Vocabulary – Contextual meaning of words		CO1
UNIT II	**EXPRESSING CASUAL RELATIONS IN SPEAKING AND WRITING**	**9**
Listening - Listening to longer technical talks and completing– gap filling exercises. Listening to technical information from podcasts – Listening to process/event descriptions to identify cause & effects - Speaking – Describing and discussing the reasons of accidents or disasters based on news reports. Reading - Reading longer technical texts– Cause and Effect Essays, and Letters/ emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds; Vocabulary – Word Formation (Noun-Verb-Adj-Adv), Purpose statements.		CO2
UNIT III	**PROBLEM SOLVING**	**9**
Listening – Listening to / Watching movie scenes/ documentaries depicting a technical problem and suggesting solutions. Speaking – Group Discussion (based on case studies) - techniques and Strategies, Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences Vocabulary - Compound Words, Sentence Completion.		CO3
UNIT IV	**REPORTING OF EVENTS AND RESEARCH**	**9**
Listening – Listening Comprehension based on news reports – and documentaries – Precise writing, Summarising, Speaking –Interviewing, Presenting an oral report, Mini presentations on select topics; Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Subject-verb agreement, Vocabulary – Conjunctions- use of prepositions		CO4
UNIT V	**THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY**	**9**
Listening – Listening to technical talks, Presentations, Formal job interviews, (analysis of the interview performance); Speaking – Participating in a Role play, (interview/telephone interview), virtual interviews, Making presentations with visual aids; Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship		CO5

application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses Vocabulary – Easily confused words.	

TOTAL: 45 HOURS

TEXT BOOKS

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.

REFERENCE BOOKS

1. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
2. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
4. Developing Communication Skills by Krishna Mohan, Meera Banerji-Macmillan India Ltd. 1990,Delhi.

	COURSE OUTCOMES **Upon completion of the course, students will be able to**
CO1	To compare and contrast products and ideas in technical texts.
CO2	To identify cause and effects in events, industrial processes through technical texts.
CO3	To analyse problems in order to arrive at feasible solutions and communicate them orally and in the written format.
CO4	To report events and the processes of technical and industrial nature.
CO5	To present their opinions in a planned and logical manner, and draft effective resumes in context of job search.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	-	-	1	1	-	1	1	-	1	2	2	2	2	-	1	1
CO2	-	-	1	1	-	1	1	-	1	2	2	2	2	-	2	1
CO3	-	-	2	1	-	-	1	-	1	3	2	2	1	-	2	1
CO4	-	-	2	1	-	2	2	1	2	3	2	3	1	-	2	1
CO5	-	-	1	2	-	2	2	1	1	3	2	3	2	-	1	1

MA4202	STATISTICS AND NUMERICAL METHODS	L	T	P	C
	(Common for all branches of B.E. / B. Tech Programmes)	3	1	0	4

OBJECTIVES

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce 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.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	TESTING OF HYPOTHESIS	12
Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.		CO1
UNIT II	**DESIGN OF EXPERIMENTS**	**12**
One way and two-way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.		CO2
UNIT III	**SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS**	**12**
Solution of algebraic and transcendental equations by Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalue of a matrix by Power method.		CO3
UNIT IV	**INTERPOLATION AND NUMERICAL CALCULUS**	**12**
Interpolations – Newton's forward, Newton's backward and Lagrange's - Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.		CO4
UNIT V	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**12**
Single step methods: Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams- Bash forth predictor corrector methods for solving first order differential equations.		CO5

TOTAL : 60 HOURS

TEXT BOOKS

1. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A.,"Schaum's Outlines on Probability and

Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2	Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3	Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
CO4	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
CO5	Solve the ordinary differential equations with initial conditions by using certain techniques with engineering applications.

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)												PROGRAM SPECIFIC OUTCOMES (PSOs)			
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	-	-	-	-	-	-	1	1	1	1	1
CO2	2	3	1	1	2	-	-	-	-	-	-	1	1	1	1	1
CO3	2	2	1	1	1	-	-	-	-	-	-	1	2	2	2	1
CO4	2	2	1	0	1	-	-	-	-	-	-	1	2	2	2	1
CO5	3	2	2	1	0	-	-	-	-	-	-	1	2	3	2	1

PH4252	PHYSICS FOR ELECTRONICS ENGINEERING	L	T	P	C
	Common for ECE and EEE branches	3	0	0	3

OBJECTIVES

Enable the students to

- ❖ Understand the transport properties of conducting materials and their modeling using classical and quantum theories,
- ❖ Acquire knowledge in semiconductors and their applications in various devices
- ❖ Grasp the principles of magnetic and dielectric materials and their applications
- ❖ Understand the functioning of optical materials for optoelectronics Understand the basics of quantum structures, properties of nano materials and their applications.

UNIT I	CONDUCTING MATERIALS	9
Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, expression -Wiedemann-Franz law - Success and failures - electrons in metals - Particle in a three dimensional box -degenerate states - Fermi-Dirac statistics - Density of energy states - Electron in periodic potential: Bloch theorem - metals and insulators - Energy bands in solids - tight binding		CO1

approximation - Electron effective mass - concept of hole.		
UNIT II	**PHYSICS OF SEMICONDUCTOR DEVICES**	**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 - carrier transport: velocity-electric field relations drift and diffusion transport - Einstein's relation - Hall effect and devices - Zener and avalanche breakdown in p-n junction diode - Zener diode as voltage regulator - Ohmic contacts - tunnel diode - Schottky diode -MOS Capacitor.		**CO2**
UNIT III	**MAGNETIC AND DIELECTRIC MATERIALS**	**9**
Origin of magnetic moment - Bohr magneton - Microscopic and macroscopic classification of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials - Domain theory - Hysteresis (based on domain theory) - soft and hard magnetic materials - Ferrites - applications. Dielectric materials: Polarization processes - internal field - Clausius-Mosotti relation - dielectric loss - dielectric breakdown.		**CO3**
UNIT IV	**OPTICAL MATERIALS**	**9**
Classification of optical materials - carrier generation and recombination processes -Absorption, emission and scattering of light in metals, insulators and semiconductors (concepts only) - photo current in p-n junction diode - solar cell - photo detectors - LED - Organic LED - excitons - quantum confined Stark effect - quantum dot laser, quantum well laser.		**CO4**
UNIT V	**NANO ELECTRONIC DEVICES**	**9**
Introduction - electron density in bulk material - size dependence of Fermi energy - quantum confinement -quantum structures - Density of states in quantum well, quantum wire and quantum dot structures - resonant tunneling - quantum interference effects - mesoscopic structures - Coulomb blockade effects - Single electron phenomena and Single electron Transistor – magnetic semiconductors - spintronics, Spintronic Devices: Spin Valve, Spin FET- Carbon nanotubes: Types ,Preparation-CVD, Properties and applications.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Ben Streetman and Sanjay Banerjee Solid State Electronic Devices, Prentice Hall, 6th Edition, 2005.
2. Donald Neaman, Dhrubes Biswas, Semiconductor Physics and Devices (SIE), 4th Edition, 2017.
3. Umesh K Mishra & Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2008.
4. Adaptation by Balasubramanian, R, Callister, Material Science and Engineering, Wiley India Pvt. Ltd., 2nd Edition, 2014.
5. Mani. P, Physics for Electronics Engineering, Dhanam Publishers, 2017.
6. Salivahanan, S., Rajalakshmi, A., Karthie, S., Rajesh, N. P., Physics for Electronics Engineering and Information Science, McGraw Hill Education (India) Private Limited, 2018.

REFERENCE BOOKS

7.Traugott Fischer, Materials Science for Engineering Students, 1st Edition, Elsevier, 2009.
8.Budinski, K.G. & Budinski, M.K. Engineering Materials Properties and Selection, Prentice Hall, 2009.
9.Rogers, B., Adams, J., & Pennathur, S. Nanotechnology: Understanding Small Systems, CRC Press, 2014.
10.Hanson, G.W. Fundamentals of Nanoelectronics, Pearson Education, 2009.
11.Kwok Ng, Simon Sze, and Yiming Li, Physics of Semiconductor Devices, 2006

COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Gain knowledge on classical and quantum free electron theories and formation of energy band structures.
CO2	Gain knowledge on semiconducting devices and its applications.
CO3	Acquire knowledge on magnetic and dielectric materials and their applications.
CO4	Understand the relationship of optoelectronic materials and their applications.
CO5	Acquire knowledge about the nano structures and its applications.

MAPPING OF COs WITH POs AND PSOs																
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**-**
CO2	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**-**
CO3	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**-**
CO4	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**3**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**3**	**-**	**3**	**-**

GE4204	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
Common for all Branches of B.E. / B. Tech Programmes		3	0	0	3

OBJECTIVES

- To study the inter relationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world;envision the surrounding environment, its functions and its value.
- To find and implement scientific, technological, economic and political solutions toenvironmental problems.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.
- To study the dynamic processes and understand the features of the earth‘s interior and surface.

UNIT I	**ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY**	**9**
Definition, scope and importance of environment – Need for public awareness – Role of Individual in Environmental protection – Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Food chains, food webs and ecological pyramids – Ecological succession – Types, characteristic features, structure and function of forest, grass land, desert and aquatic (ponds, lakes, rivers, oceans, estuaries) ecosystem. Biodiversity – Definition – Genetic, species and ecosystem diversity – Value of biodiversity – Consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega diversity nation – Hot spots of biodiversity – Threats to biodiversity– Habitat loss, poaching of wild life, human-wildlife conflicts – Wildlife		**CO1**

protection act and forest conservation act – Endangered and endemic species – Conservation of biodiversity – In-situ and ex-situ conservation of biodiversity.		
UNIT II	**ENVIRONMENTAL POLLUTION**	**9**
Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: causes, effects and control measures of municipal solidwastes – Problems of e-waste – Role of an individual in prevention of pollution – Pollution casestudies – Disaster management – Floods, earthquake, cyclone, tsunami and landslides – Field study of local polluted site – Urban / Rural / Industrial / Agricultural.		**CO2**
UNIT III	**NATURAL RESOURCES**	**9**
Forest resources: Uses and over-exploitation – Deforestation – Case studies – Timber extraction, mining, dams and their effects on forests and tribal people – Water resources – Use and overutilization of surface and ground water, floods, drought, conflicts over water – Dams:benefits and problems – Mineral resources: Uses and exploitation – Environmental effects ofextracting and using mineral resources – Case studies – Food resources: World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture: fertilizer– pesticide problems, water logging, salinity – Case studies – Energy resources: Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Case studies – Land resources: Land as a resource – Land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles – Field study of local area to document environmental assets – River / Forest / Grassland / Hill / Mountain.		**CO3**
UNIT IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
From unsustainable to sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Role of non-governmental organization – Environmental ethics – Issues and possible solutions – Climate change – Global warming – Acid rain, Ozone layer depletion –Nuclear accidents and holocaust – Case studies – Wasteland reclamation		**CO4**
— Consumerism and waste products — Principles of Green Chemistry — Environment protection act – Air (Prevention and Control of Pollution) Act – Water (Preventionand control of Pollution) Act – Wildlife protection Act – Forest conservation Act – Enforcementmachinery involved in environmental legislation– Central and state pollution control boards– National Green Tribunal – Public awareness.		
UNIT V	**HUMAN POPULATION AND THE ENVIRONMENT**	**9**
Population growth – Variation among nations – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV / AIDS – COVID 19 – Women and child welfare – Role of information technology in environment and human health – Case studies		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Benny Joseph, ‗Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2014).
2. Gilbert M.Masters, ‗Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, (2004).
3. Dr. A. Sheik Mideen and S.Izzat Fathima, ―Environmental Science and Engineering‖, Airwalk Publications, Chennai, (2018).

REFERENCE BOOKS

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, (2007).
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press (I) Pvt, Ltd, Hydrabad, (2015).

3. G. Tyler Miller,Scott E. Spoolman, "Environmental Science", Cengage Learning IndiaPvt. Ltd, Delhi, (2014).
4. R. Rajagopalan, Environmental Studies-From Crisis to Cure', Oxford University Press, (2005).
5. Anubha Kaushik , C.P. Kaushik, "Perspectives in Environmental Studies", New Age International Pvt. Ltd, New Delhi, (2004).
6. Frank R. Spellman, "Handbook of Environmental Engineering", CRC Press, (2015).

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To obtain knowledge about environment, ecosystems and biodiversity.
CO2	To take measures to control environmental pollution.
CO3	To gain knowledge about natural resources and energy sources.
CO4	To find and implement scientific, technological, economic and political solutions toenvironmental problems.
CO5	To understand the impact of environment on human population.

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES(POs)												PROGRAM SPECIFIC OUTCOMES(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	3	3	3	2	2	2	3	2	1	2	2
CO2	3	2	3	3	2	3	3	3	3	2	2	3	2	2	2	3
CO3	3	3	2	2	3	3	2	2	1	2	1	3	2	2	2	3
CO4	3	3	3	3	1	2	3	3	2	2	2	2	2	1	2	3
CO5	3	2	3	2	3	3	3	2	2	2	2	3	3	2	3	3

EE4205	**CIRCUIT ANALYSIS**	**L**	**T**	**P**	**C**
		3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of DC and AC circuits behavior
- To study the transient and steady state response of the circuits subjected to step and sinusoidal excitations.
- To introduce different methods of circuit analysis using Network theorems, duality and topology.

UNIT I	**BASIC CIRCUITS ANALYSIS AND NETWORK TOPOLOGY**	**12**
Ohm's Law – Kirchhoff's laws – Mesh current and node voltage method of analysis for D.C and A.C. circuits - Network terminology - Graph of a network - Incidence and reduced incidence matrices – Trees –Cut sets - Fundamental cut sets - Cut set matrix – Tie sets –Link currents and Tie set schedules -Twig voltages and Cut set schedules, Duality and dual networks		**CO1**
UNIT II	**NETWORK THEOREMS FOR DC AND AC CIRCUITS**	**12**
Network theorems -Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Millman's theorem, and Maximum power transfer theorem ,application of Network theorems- Network reduction: voltage and current division, source transformation – star delta		**CO2**

conversion.		
UNIT III	**RESONANCE AND COUPLED CIRCUITS**	**12**
Resonance - Series resonance - Parallel resonance - Variation of impedance with frequency – Variation in current through and voltage across L and C with frequency – Bandwidth - Q factor - Selectivity. Self-inductance - Mutual inductance - Dot rule - Coefficient of coupling - Analysis of multilinking coupled circuits - Series, Parallel connection of coupled inductors - Single tuned coupled circuits.		**CO3**
UNIT IV	**TRANSIENT ANALYSIS**	**12**
Natural response-Forced response - Transient response of RC, RL and RLC circuits to excitation by Step Signal, Impulse Signal and exponential sources - Complete response of RC, RL and RLC Circuits to sinusoidal excitation.		**CO4**
UNIT V	**TWO PORT NETWORKS**	**12**
Two port networks, Z parameters, Y parameters, Transmission (ABCD) parameters, Hybrid (H) Parameters, Interconnection of two port networks, Symmetrical properties of T and π networks.		**CO5**
		TOTAL : 60 HOURS

TEXT BOOKS

1.William H. Hayt, Jr. Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", McGraw Hill Science Engineering, Eighth Edition, 11th Reprint 2016.

2. Joseph Edminister and Mahmood Nahvi, "Electric Circuits, Schaum‘s Outline Series", Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

REFERENCE BOOKS

1. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth
2. Edition, McGraw Hill, 9th Reprint 2015.
3. A. Bruce Carlson, "Circuits: Engineering Concepts and Analysis of Linear Electric
4. Circuits", Cengage Learning, India Edition 2nd Indian Reprint 2009.
5. Allan H. Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To Develop the capacity and analyze electrical circuits, apply the circuit theorems in real time.
CO2	To impart knowledge on solving circuits using network theorems
CO3	To introduce the phenomenon of resonance in coupled circuits.
CO4	To educate on obtaining the transient response of circuits.
CO5	To model any device using two port networks.

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)												PROGRAM SPECIFIC OUTCOMES (PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	3	2	1	-	-	-	-	1	1	3	1	-	-
CO2	3	3	2	3	2	1	-	-	-	-	1	1	3	1	-	-
CO3	3	3	2	3	2	1	-	-	-	-	1	1	3	1	-	-
CO4	3	3	2	3	2	1	-	-	-	-	1	1	3	1	-	-
CO5	3	3	2	3	2	1	-	-	-	-	1	1	3	1	-	-

EC4206	ELECTRONIC DEVICES	L	T	P	C
		3	0	0	3

OBJECTIVE

- To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field-effect Transistors,
- Power control devices, LED, LCD and other Opto-electronic devices.

UNIT I	SEMICONDUCTOR DIODES	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, Zener Diode – Reverse Bias Characteristics.		**CO1**
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- Gummel Poonmodel,Multi-EmitterTransistor.		**CO2**
UNIT III	**FIELD EFFECT TRANSISTOR**	**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		**CO3**
UNIT IV	**SPECIAL SEMICONDUCTOR DEVICES**	**9**
Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR..		**CO4**
UNIT V	**POWER DEVICES AND DISPLAY DEVICES**	**9**
UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Phototransistor, Opto Coupler, Solar cell, CCD.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1 .Donald A Neaman, - Semiconductor Physics and Devices‖, Fourth Edition, Tata Mc Graw Hill Inc. 2012.

2. Salivahanan. S, Suresh Kumar. N, Vallavaraj. A, - Electronic Devices and circuits, Third Edition, Tata McGraw- Hill, 2008.

REFERENCE BOOKS

1 Robert Boylestad and Louis Nashelsky,- Electron Devices and Circuit Theory Pearson Prentice Hall, 10th edition, 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.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To analyze the operation and characteristics of the PN junction diode
CO2	To analyze the operation and characteristics of Bipolar junction transistor (BJT).
CO3	To understand and analyze the Field-effect transistor – JFET, MOSFET.
CO4	To study and analyze the special semiconductor devices like MESFET, FINFET, PINFET,CNTFET, Varactor diode, Tunnel Diode, GaAs Devices, LASER, and LDR Diode.

CO5	To understand the basic concepts of Power and Display devices

MAPPING OF COs WITH POs AND PSOs																
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**2**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**2**	**-**	**-**
CO3	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**2**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**2**	**-**	**-**
CO5	**3**	**3**	**2**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**2**	**-**	**-**

GE4251	**TAMILS AND TECHNOLOGY**	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	1	0	0	1
UNIT I	**WEAVING AND CERAMIC TECHNOLOGY**				**3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) — Graffiti on Potteries.					**CO1**
UNIT II	**DESIGN AND CONSTRUCTION TECHNOLOGY**				**3**
Designing and Structural construction House & Designs in household materials during Sangam Age Building materials and Hero stones of Sangam age — Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and otherworship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.					**CO2**
UNIT III	**MANUFACTURING TECHNOLOGY**				**3**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.					**CO3**
UNIT IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**				**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries — Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.					**CO4**
UNIT V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**				**3**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.					**CO5**
					TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

GE4251	தமிழரும் தொழில்நுட்பம்	**L**	**T**	**P**	**C**
	Common for all branches of B.E. / B. Tech Programmes	1	0	0	1

அலகு I	நெசவு மற்றும் பானை தொழில்நுட்பம்	**3**
சங்க காலத்தில் நெசவு தொழில் - பானை தொழிநுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.		**CO1**
அலகு II	வடிவறமப்பு மற்றும் கட்டிடத்மதொழில்நுட்பம்	**3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் –சோழர்காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நொயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள்		**CO2**

– பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோசாரோசெனிக் கட்டிடக் கலை.		
அலகு III	உற்பத்தித் தொழில்நுட்பம்	**3**
கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்று சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள்- கல்மணிகள் - கண்ணாடி மணிகள்- சுடுமண் மணிகள் - சங்கு மணிகள்- எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		**CO3**
அலகு IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	**3**
அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு - கால்நடைகளுக்கு வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மையைச் சார்த்த செயல்பாடுகள் - கடல்சார் அறிவு – மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.		**CO4**
அலகு V	அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	**3**
அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் இணையத்தில் தமிழ் அகராதிகள் சொற்குவை திட்டம்.		**CO5**
		TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
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6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

GE 4207	ENGINEERING PRACTICES LABORATORY	L	P	T	C
(Common to all branches of B.E. / B. Tech Programmes)		0	0	4	2

OBJECTIVES

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

LIST OF EXPERIMENTS

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE **13**

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions,reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipeconnections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise: Wood work, joints by sawing, planing and cutting.

CO1

II MECHANICAL ENGINEERING PRACTICE 18 **Welding:** a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding. b) Gas welding practice **Basic Machining:** a) Simple Turning and Taper turning b) Drilling Practice **Sheet Metal Work:** a) Forming & Bending. b) Model making – Trays and funnels. c) Different type of joints. **Machine assembly practice:** a) Study of centrifugal pump b) Study of air conditioner **Demonstration on:** a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt. b) Foundry operations like mould preparation for gear and step cone pulley. c) Fitting – Exercises – Preparation of square fitting and V – fitting models.	**CO2**

GROUP B (ELECTRICAL & ELECTRONICS)	
III ELECTRICAL ENGINEERING PRACTICE 13 1.Residential house wiring using switches, fuse, indicator, lamp and energy meter. 2.Fluorescent lamp wiring. 3.Stair case wiring 4.Measurement of electrical quantities – voltage, current, power & power factor in RLCcircuit.	**CO3**
5.Measurement of energy using single phase energy meter. 6.Measurement of resistance to earth of an electrical equipment.	**CO4**
IV ELECTRONICS ENGINEERING PRACTICE 16 1. Study of electronic components and equipment‘s — Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering practice – Components Devices and Circuits – Using general purpose PCB. Measurement of ripple factor of HWR and FWR.	**CO5**
TOTAL: 60 HOURS	

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity required
	CIVIL	
1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 sets

2.	Carpentry vice (fitted to work bench)	15 Nos
3.	Standard woodworking tools 15 Sets.	15 Sets.
4.	Models of industrial trusses, door joints, furniture joints	5 each
5.	**Power Tools:** (a) Rotary Hammer (b) Demolition Hammer (c) Circular Saw (d) Planer (e) Hand Drilling Machine (f) Jigsaw	2 Nos
MECHANICAL		
1.	Arc welding transformer with cables and holders.	5 Nos
2.	Welding booth with exhaust facility.	5 Nos
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos
5.	Centre lathe.	2 Nos
6.	Hearth furnace, anvil and smithy tools.	2 Sets
7.	Moulding table, foundry tools.	2 Sets
8.	Power Tool: Angle Grinder.	2 Nos
9.	**Study-purpose items:** centrifugal pump, air-conditioner.	1 each
ELECTRICAL		
1.	Assorted electrical components for house wiring.	15 Sets
2.	Electrical measuring instruments.	10 Sets
3.	**Study purpose items:** Iron box, fan and regulator, emergency lamp.	1 each
4.	Megger (250V/500V).	1 No.
5.	**Power Tools:** (a) Range Finder (b) Digital Live-wire detector	2 Nos
ELECTRONICS		
1.	Soldering guns 10 Nos.	10 Nos.
2.	Assorted electronic components for making circuits 50 Nos.	50 Nos.
3.	Small PCBs.	10 Nos.
4.	Multimeters	10 Nos.
5.	**Study purpose items:** Telephone, FM radio, low-voltage power supply	1 each

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Fabricate carpentry components and pipe connections including plumbing works. Use welding equipment‘s to join the structures.
CO2	Carry out the basic machining operations Make the models using sheet metal works
CO3	Carry out basic home electrical works and appliances.

CO4	Measure the electrical quantities
CO5	Elaborate on the components, gates, soldering practices

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)												PROGRAM SPECIFIC OUTCOMES (PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	1	3	-	-	3	-	-	-	-	-	3	2	2	1	2
CO2	3	2	3	-	-	3	-	-	-	-	-	3	2	2	1	2
CO3	3	1	2	-	-	2	-	-	-	-	-	3	2	2	1	2
CO4	3	2	3	3	1	3	1	1	1	1	2	3	2	2	1	2
CO5	3	2	3	3	1	2	1	1	1	1	2	3	2	2	1	2

EC 4208	CIRCUITS AND DEVICES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To learn the characteristics of basic electronic devices such as Diode, BJT, FET, SCR
- To understand the working of RL, RC and RLC circuits
- To gain hand on experience in Thevenin & Norton theorems, KVL & KCL, and Superposition theorems.

LIST OF EXPERIMENTS:

1. Characteristics of PN Junction Diode
2. Zener diode Characteristics and Regulator using Zener diode
3. Common Emitter input-output Characteristics
4. Common Base input-output Characteristics
5. FET Characteristics
6. SCR Characteristics
7. Clipper and Clamper & FWR
8. Verifications of Thevenin & Norton theorem
9. Verifications of KVL & KCL
10. Verifications of Super Position Theorem
11. Verifications of maximum power transfer & reciprocity theorem
12. Determination of Resonance Frequency of Series & Parallel RLC Circuits
13. Transient analysis of RL and RC circuits

TOTAL: 60 HOURS

LABORATORY REQUIREMENTS:

1.	BC 107, BC 148,2N2646, BFW10	25 each
2.	1N4007, Zener diodes	25 each
3.	Resistors, Capacitors, Inductors	Sufficient Quantities
4.	Bread Boards	15 Nos.
5.	CRO (30MHz)	15 Nos.
6.	Function Generators (3MHz)	10 Nos.

7.	MSO- Mixed Signal Oscilloscope (100 MHz)	04 Nos.
8.	Dual Regulated Power Supplies (0 – 30V)	10 Nos.

COURSE OUTCOMES:

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

- Analyze the characteristics of basic electronic devices
- Design RL and RC circuits
- Verify Thevenin's & Norton's theorem KVL & KCL, and Super Position Theorems

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)												PROGRAM SPECIFIC OUTCOMES (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1	-	-	-	-	-	2	2	3	1	-	-
CO2	3	3	3	3	1	-	-	-	-	-	2	2	3	-	-	-
CO3	3	3	3	3	1	-	-	-	-	-	2	2	3	-	-	-

SEMESTER III

MA4352	TRANSFORMS AND COMPLEX FUNCTIONS	L	T	P	C
	(Common to MECH, EEE & ECE)	3	1	0	4

OBJECTIVES

- This course is designed to cover topics such as Complex Analysis, Ordinary Differential Equations, Z- Transforms and Laplace Transform.
- To develop an understanding of the standard techniques analytic function and its mapping property.
- To familiarize the students with complex integration and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z-transform techniques for discrete time systems
- To apply Laplace transforms for solving the problems that occur in various branches of engineering disciplines.

UNIT I	ANALYTIC FUNCTIONS	9+3
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions w = Z + C, CZ, 1/Z - Bilinear transformation		CO1

UNIT II	**COMPLEX INTEGRATION**	**9+3**
Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour(excluding poles on the real line)		**CO2**
UNIT III	**ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Higher order linear differential equations with constant coefficients - Method of variation of parameters– Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients		**CO3**
UNIT IV	**Z – TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**
Z-transforms – Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems – Convolution theorem – Formation of difference equations – Solution of difference equations using Z – transform.		**CO4**
UNIT V	**LAPLACE TRANSFORMS**	**9+3**
Existence conditions – Transforms of elementary functions –Basic properties - Shifting theorems - transforms of derivatives and integrals — Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients		**CO5**
		TOTAL : 60 HOURS

TEXT BOOKS:

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCE BOOKS:

1. G Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., ― Advanced Engineering Mathematics, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O_Neil, P.V. ―Advanced Engineering Mathematics‖, Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Understand Analytic functions, conformal mapping & Bilinear transformation.
CO2	Evaluate real integration by Complex integration techniques.
CO3	Apply various techniques in solving ordinary differential equations.
CO4	Use the effective mathematical tools for the solutions of partial differential equations by using Z-transform techniques for discrete time systems.
CO5	Apply Laplace transform and inverse transform of simple functions, properties, various related theorems in solving differential equations with constant coefficients.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**	**PROGRAM SPECIFIC OUTCOMES (PSOs)**

	PO1	PO2	PO3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	-	-	-	-	1	2	2	3	1
CO2	3	3	3	2	2	2	1	-	-	-	-	1	3	2	2	1
CO3	3	3	3	2	3	3	2	-	-	1	1	3	2	2	3	1
CO4	3	1	1	1	2	1	1	1	2	2	1	-	3	2	2	1
CO5	3	3	3	2	2	2	1	-	-	-	-	1	2	2	2	1

CS4352	DATA STRUCTURES USING C	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques

UNIT I	C PROGRAMMING FUNDAMENTALS	9
Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.		CO1
UNIT II	**C PROGRAMMING - ADVANCED FEATURES**	**9**
Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Preprocessor Directives.		CO2
UNIT III	**LINEAR DATA STRUCTURES**	**9**
Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.		CO3
UNIT IV	**NON-LINEAR DATA STRUCTURES**	**9**
Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing – Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing - Graph and its representations – Graph Traversals.		CO4
UNIT V	**SORTING AND SEARCHING TECHNIQUES**	**9**
Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.		CO5
	Total Hours	**45**

	TEXTBOOKS
1	Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2016.
2	Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1997.
	REFERENCE BOOKS
1.	Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
2.	Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3.	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4.	Ellis Horowitz, Sartaj Sahni and Susan Anderson, “Fundamentals of Data Structures”,

	Galgotia, 2008
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Describe linear data structures using array and linked list
CO2	Apply data structures like stacks, queues in linear data structure
CO3	Discuss non-linear data structures tree and its application
CO4	Apply various algorithms in graph
CO5	Solve searching, sorting and hashing techniques in data structures

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	1	-	1	-	1	-	1	-	1	2	1	1	1	1
CO2	2	2	1	-	1	-	1	-	1	-	1	2	1	1	1	1
CO3	3	2	2	2	1	-	1	-	1	-	1	2	1	1	1	1
CO4	3	2	2	2	1	-	1	-	1	-	1	2	1	1	1	1
CO5	3	2	2	2	1	-	1	-	1	-	1	2	1	1	1	1

EC4303	**ELECTRONIC CIRCUITS AND ITS APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the methods of biasing transistors
- To analyze the frequency response of transistors
- To study about feedback amplifiers, tuned amplifiers and oscillators principles
- To design and analyze single stage and multistage amplifier circuits
- To design and analyze the power supplies & DC/DC converters

UNIT I	**BJT & MOSFET AMPLIFIERS**	**9**
Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS, CG and Source follower – Gain and frequency response- High frequency analysis, Practical applications of BJT & MOSFET amplifiers.		**CO1**
UNIT II	**MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER**	**9**
Darlington Amplifier, Cascade & Cascode amplifiers, Differential amplifier – Common mode and Difference mode analysis, Configurations of Differential Amplifier.		**CO2**
UNIT III	**FEEDBACK & TUNED AMPLIFIERS**	**9**
Feedback Types, Analysis of series-series, shunt-shunt and shunt-series feedback amplifiers, tank circuits, small signal tuned amplifiers - double tuned amplifier, effect of cascading single tuned and double tuned amplifiers on bandwidth, Practical applications of tuned amplifiers		**CO3**
UNIT IV	**OSCILLATORS & MULTIVIBRATORS**	**9**
Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators-Multivibrators-Astable, Bistable and Monostable multivibrators design and waveform.		**CO4**

UNIT V	POWER SUPPLIES & DC CONVERTERS	9
Linear regulated power supply — Rectifiers — Filters — Half-Wave Rectifier Power Supply — Full- Wave Rectifier Power Supply, Switched mode power supply (SMPS) — DC/DC convertors — Buck, Boost, Buck-Boost analysis and design, Practical applications of Power supply.		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.(UNIT I, II, III, IV)	
2.	Sedra and Smith, “Micro Electronic Circuits”; Sixth Edition, Oxford University Press, 2011. (UNIT III,IV,V)	
	REFERENCE BOOKS	
1.	Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.	
2.	Salivahanan and N. Suresh Kumar, Electronic Devices and Circuits, 4th Edition, , Mc Graw Hill Education (India) Private Ltd., 2017.	
3.	Millman J, Halkias.C.and Sathyabrada Jit, Electronic Devices and Circuits, 4th Edition, Mc Graw Hill Education (India) Private Ltd., 2015.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Acquire knowledge of working principles, characteristics, performance of small signal BJT and MOSFET amplifiers.	
CO2	Acquire knowledge of multistage amplifiers.	
CO3	Understand the design of feedback & tuned amplifiers	
CO4	Understand the design LC and RC oscillators &, multivibrators,	
CO5	Acquire knowledge of power supplies & DC/DC converters and its applications.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	1	2	-	-	-	-	-	1	2	1	1	1
CO2	3	3	3	2	2	2	-	-	-	-	-	1	2	1	1	1
CO3	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1	1
CO4	3	3	3	1	2	2	-	-	-	-	-	1	2	1	1	1
CO5	3	3	3	1	3	2	-	-	-	-	-	1	3	1	1	1

EC4304	DIGITAL CIRCUITS AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To present the basics of digital circuits and simplification methods
- To design various combinational digital circuits using logic gates
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits
- To understand programmable concepts using Verilog for combinational and sequential circuits
- To learn working of IC families and introduce configuration of semiconductor memories and its applications**.**

UNIT I	FUNDAMENTALS OF DIGITAL SYSTEMS	9
Review of number systems-representation-conversions, Review of Boolean algebra- theorems, sum of product and product of sum simplification, Minterm and Maxterm, Standard representation of Boolean Function, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates, Quine-McCluskey methods.		**CO1**
UNIT II	**COMBINATIONAL LOGIC CIRCUITS**	**9**
Analysis and design procedure of combinational circuits - Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Code-Converters, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Multiplexer, Demultiplexer, Case studies: Design of 8 bit Arithmetic and logic unit, Parity Generator/Checker, Seven Segment display decoder – Introduction to Verilog program for Combinational Circuits		**CO2**
UNIT III	**SYNCHRONOUS SEQUENTIAL LOGIC**	**9**
Storage elements-Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, – Design of Moore/Mealy models Analysis and design of clocked sequential circuits, state minimization, state assignment, lock - out condition circuit implementation - Counters, Ripple Counters, Special Counters, Shift registers, Universal Shift Register. Designing of rolling display/real time clock – Introduction to Verilog program for Sequential Circuits.		**CO3**
UNIT IV	**ASYNCHRONOUS SEQUENTIAL LOGIC**	**9**
Types of states-state reduction-state assignment-Analysis of Asynchronous circuits, cycles and races, race free assignments, Hazards - types, Implementation of Hazard free circuits. Analysis of asynchronous sequential circuits, Design of Fundamental and Pulse mode asynchronous sequential circuits.		**CO4**
UNIT V	**DIGITAL INTEGRATED CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	**9**
Logic families - RTL, TTL, ECL, CMOS - Characteristics of Logic families, - Propagation Delay, Fan - In and Fan - Out - Noise Margin – Structure of Memory, static ROM, PROM, EEPROM EAPROM; Implementation of circuits by programmable logic devices – PROM, PLA and PAL.		**CO5**
	Total Hours:	**45**

	TEXTBOOKS
1.	M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 5th Edition, 2013.(Unit - I - V)

	REFERENCE BOOKS
1.	Charles H. Roth, Jr, 'Fundamentals of Logic Design', Jaico Books, 4th Edition, 2002.
2.	William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India, 1980.
3.	Floyd T.L., "Digital Fundamentals", Charles E. Merril publishing company,1982.
4.	John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 4 th Edition,2007.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Use Boolean algebra and simplification procedures relevant to digital logic.
CO2	Design various combinational digital circuits using logic gates.
CO3	Analyze, design and simulate synchronous sequential circuits.
CO4	Analyze design and simulate asynchronous sequential circuits
CO5	Build logic gates and use programmable devices

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	3	2	1	2	-	-	-	-	2	2	3	3	2	1
CO2	3	3	3	2	2	2	-	-	-	-	2	3	3	3	2	2
CO3	3	3	3	2	2	2	-	-	-	-	2	3	3	3	2	2
CO4	3	3	3	2	2	2	-	-	-	-	2	3	3	3	2	2
CO5	3	3	3	3	3	2	-	-	-	-	3	3	3	3	3	3

EC4305	**CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the components and their mathematical models
- To learn various methods for analyzing the time response, frequency response and stability of the systems.
- To learn the various approaches for the state variable analysis.

UNIT I	**MATHEMATICAL MODELS OF CONTROL SYSTEMS**	**9**
Basic Structure of Control System – Closed loop and Open Loop System – Modeling of Electrical and Mechanical System - Transfer Function - Block diagram Models – Reduction method - Signal flow graphs models - DC and AC Servo Systems		**CO1**
UNITII	**TIME RESPONSE ANALYSIS**	**9**
Standard test signals - Measures of performance of the standard first order system – Impulse and step response analysis of second order system-effect of adding a zero to the system - steady error constant - System type number – P, PD, PI, PID controllers		**CO2**

UNIT III	**FREQUENCY RESPONSE ANALYSIS**	**9**
Performance specification in frequency domain - Frequency response of standard second order system - Bode Plot - Polar Plot - Design of compensators using Bode plots – lead, lag, lag-lead compensation.		**CO3**
UNIT IV	**CONCEPTS OF STABILITY ANALYSIS**	**9**
Concept of stability - Bounded-Input Bounded-Output stability - Routh stability criterion - Root locus – Rules for sketching root locus - Nyquist stability criterion		**CO4**
UNIT V	**STATE VARIABLE ANALYSIS**	**9**
State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models - Concepts of Controllability and Observability - State variable analysis of digital control system		**CO5**
	Total Hours:	**45**

	TEXTBOOKS
1.	M.Gopal,"Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.
2.	K.Ogata, "Modern Control Engineering", PHI, 5th Edition, 2012.
	REFERENCE BOOKS
1.	Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.
2.	S.K.Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013.
3.	Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition,1995.
4.	A NagoorKani, " Control Systems", CBS Publishers and Distributors Private Limited, 5th Edition, 2019
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Compute the transfer function of different physical systems.
CO2	Analyse the time domain specification and calculate the steady state error.
CO3	Illustrate the frequency response characteristics of closed loop system.
CO4	Analyse the stability using Routh and root locus techniques.
CO5	Illustrate the state space models of a physical system and discuss the concepts of sampled data control system.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	2	2	-	-	-	-	2	3	3	2	-	2
CO2	3	3	3	3	2	3	-	-	-	-	2	2	3	2	-	2
CO3	3	2	3	3	2	2	-	-	-	-	2	3	3	2	-	2
CO4	3	3	3	2	2	2	-	-	-	-	2	2	3	2	-	2
CO5	2	2	3	3	2	3	-	-	-	-	2	3	3	2	-	2

EC4306	ELECTROMAGNETIC FIELDS	L	T	P	C
	(Common to Electronics and Communication Engineering)	3	0	0	3

OBJECTIVES:

- To gain knowledge on the basics of vector calculus and coordinate systems.
- To attain comprehensive knowledge in static electric and magnetic fields.
- To gain conceptual understating of time varying electric and magnetic fields using Maxwell's Equation.
- To give insight into the propagation of EM waves.
- To analytically solve problems in all the above topics.

UNIT I	VECTOR ANALYSIS OF ELECTROMAGNETIC MODEL	9
Overview of Vector Calculus, Introduction to different Coordinate Systems –Rectangular, Cylindrical and Spherical, Gradient of a scalar, Line , Surface and Volume Integrals, Divergence of vector field , Divergence Theorem , Curl of vector field, Stokes Theorem, Electromagnetic Model, Units and Constants, Null identities, Helmholtz's Theorem.		CO1
UNIT II	**STATIC ELECTRIC FIELD**	**9**
Force between charges – Law and its applications, Electric Field Strength, Electric Flux Density, Relation between Flux density and charge – Law and its applications, Electric Dipole and Potential, Relevance between Electric Field and Potential, Current and Current Density with basic laws governing current, Boundary Conditions of Electric field, Analytical study of Poisson and Laplace Equations, Electric energy storage devices with its types- Capacitor.		CO2
UNIT III	**STATIC MAGNETIC FIELD**	**9**
Force Equation on moving charges, Force produced by the current element -Biot-Savart's Law with its applications, Relation between magnetic field intensity and current -Ampere Circuital Law with its Applications, Properties of Magnetic Circuits and Torque .Types of magnetic potential with analytical Vector magnetic potential analysis, Types of Magnetic Forces and Materials, Magnetic Boundary Conditions with its applications, Magnetic Energy storage devices and its types -Solenoid and Toroid.		CO3
UNIT IV	**TIME VARYING ELECTRIC AND MAGNETIC FIELDS**	**9**
Faraday's Principle based on electromagnetic induction, Displacement current, Maxwell's Equations in differential and integral form, Analysis of Maxwell's Equation using different applications, Electromagnetic Boundary Conditions, Maxwell's equation in time varying Harmonic fields , Uniform plane Wave Equations with its mathematical Solution.		CO4
UNIT V	**PLANE WAVE PROPAGATION AND REFLECTION**	**9**
Analysis of Propagation of wave in different mediums -Free space, Dielectric and Good Conductors, Relation between electric and magnetic field, Electromagnetic power flow for a plane wave, Analysis of wave incident normally on conductor and dielectric boundary.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	William H Hayt and Jr John A Buck, "Engineering Electromagnetics" , Tata Mc GrawHill Publishing Company Ltd, New Delhi, 2008.
2.	D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 1989.
	REFERENCE BOOKS
1.	John D Kraus and Daniel A Fleisch, "Electromagnetics with Applications", Mc Graw Hill
2.	Book Co, 2005.
3.	Karl E Longman and Sava V Savov, "Fundamentals of Electromagnetics", Prentice Hall of India, New Delhi, 2006.

	Ashutosh Pramanic, "Electromagnetism", Prentice Hall of India , New Delhi, 2006.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand and apply the knowledge of vector calculus and coordinate system in electromagnetic fields.
CO2	Describe and analyze the concept of electrostatics for electromagnetics systems.
CO3	Describe and analyze the concept of Magnetostatics for electromagnetic systems.
CO4	Characterize and apply the concept of time varying electric and magnetic fields.
CO5	Understand and evaluate wave propagation in different mediums.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFIC OUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	2	2	1	2	2	-	-	-	-	1	3	3	2	1	2
CO2	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO3	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO4	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO5	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2

EC4307	**ANALOG AND DIGITAL CIRCUITS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

The student should be made to:

- ❖ Study the Frequency response of CE, CB and CC Amplifier
- ❖ Learn the frequency response of CS Amplifiers
- ❖ Study the Transfer characteristics of differential amplifier
- ❖ Perform experiment to obtain the bandwidth of single stage and multistage amplifiers
- ❖ Perform SPICE simulation of Electronic Circuits
- ❖ Design and implement the Combinational and sequential logic circuits

	ANALOG EXPERIMENTS	**18**
1.	Design and study the Frequency Response of BJT Amplifiers-CE, CB, CC amplifiers	CO1
2.	Design and study the Frequency Response of CS amplifiers	CO2
3.	Darlington Amplifier	CO3
4.	Differential Amplifiers - Transfer characteristics, CMRR Measurement	
5.	Cascode and Cascade amplifiers	
6.	Determination of bandwidth of single stage and multistage amplifiers	
	EXPERIMENTS using Simulation	**12**
1.	Analysis of BJT with Fixed bias and Voltage divider bias using Spice	CO4
2.	Analysis of FET, MOSFET with fixed bias, self-bias and voltage divider bias using simulation software using Spice	
3.	Analysis of Cascode and Cascade amplifiers using Spice	
4.	Analysis of Frequency Response of BJT and FET amplifiers using Spice	
5.	Analysis of TTL NAND Gate	

	DIGITAL EXPERIMENTS	30
1. Design and implementation of code converters using logic gates (i) BCD to excess-3 code and vice versa (ii) Binary to gray and vice-versa 2. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC 7483 3. a. Design and implementation of Multiplexer and De-multiplexer using logic gates 3.b. Design and implementation of Combinational Circuits using Multiplexer 4. Design and implementation of encoder and decoder using logic gates 5. Construction and verification of 4 bit ripple counter and Mod-10 / Mod-12 Ripple counters 6. Design and implementation of 3-bit synchronous up/down counter		CO5
	Total Hours:	**60**
LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS, 2 STUDENTS / EXPERIMENT:		
1.	**EQUIPMENTS FOR ANALOG LAB** CRO/DSO (30MHz) – 15 Nos. Signal Generator /Function Generators (3 MHz) – 15 Nos Dual Regulated Power Supplies (0 – 30V) – 15 Nos. Standalone desktop PCs with SPICE software – 15 Nos. Transistor/FET (BJT-NPN-PNP and NMOS/PMOS) – 50 Nos Components and Accessories: Resistors, Capacitors, Inductors, diodes, Zener Diodes, Bread Boards, SPICE Circuit Simulation Software: (any public domain or commercial software)	
EQUIPMENTS FOR DIGITAL LAB		
5.	Dual power supply/ single mode power supply - 15 Nos IC Trainer Kit - 15 Nos Bread Boards - 15 Nos Seven segment display -15 Nos Multimeter - 15 Nos ICs each 50 Nos 7400/ 7402 / 7404 / 7486 / 7408 / 7432 / 7483 / 74150 / 74151 / 74147 / 7445 / 7476/7491/ 555 / 7494 / 7447 / 74180 / 7485 / 7473 / 74138 / 7411 / 7474	
	COURSE OUTCOMES: On completion of this laboratory course, the student should be able to:	
CO1	Design and Test BJT/JFET amplifiers.	
CO2	Analyze the limitation in bandwidth of single stage and multi stage amplifier, cascode and cascade amplifiers.	
CO3	Measure CMRR in differential amplifier	
CO4	Simulate and analyze amplifier circuits using PSpice.	
CO5	Design and test the digital logic circuits.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	2	2	1	1	-	-	-	-	-	1	2	1	1	1
CO2	3	3	2	2	1	1	-	-	-	-	-	1	2	1	1	1
CO3	3	3	2	3	1	1	-	-	-	-	-	1	2	1	1	1
CO4	3	3	2	3	1	1	-	-	-	-	-	2	3	1	1	1
CO5	3	3	2	3	1	1	-	-	-	-	-	2	3	1	1	1

EC4307	DATA STRUCTURES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- ❖ To develop applications in C
- ❖ To implement linear and non-linear data structures
- ❖ To understand the different operations of search trees
- ❖ To get familiarized to sorting and searching algorithms

	ANALOG EXPERIMENTS	18
1.	Practice of C programming using statements, expressions, decision making and iterative statements	CO1 CO2
2.	Practice of C programming using Functions and Arrays	CO3
3.	Implement C programs using Pointers and Structures	CO4
4.	Implement C programs using Files	CO5
5.	Development of real time C applications	
6.	Array implementation of List ADT	
7.	Array implementation of Stack and Queue ADTs	
8.	Linked list implementation of List, Stack and Queue ADTs	
9.	Applications of List, Stack and Queue ADTs	
10.	Implementation of Binary Trees and operations of Binary Trees	
11.	Implementation of Binary Search Trees	
12.	Implementation of searching techniques	
13.	Implementation of Sorting algorithms : Insertion Sort, Quick Sort, Merge Sort	
14.	Implementation of Hashing – any two collision techniques	
		Total Hours: 60

	COURSE OUTCOMES: On completion of this laboratory course, the student should be able to:
CO1	Use different constructs of C and develop applications
CO2	Write functions to implement linear and non-linear data structure operations
CO3	Suggest and use the appropriate linear / non-linear data structure operations for a given problem
CO4	Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval
CO5	Implement Sorting and searching algorithms for a given application

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1	1	1	1	-	1	-	1	-	1	2	1	1	1	1
CO2	1	1	1	1	1	-	1	-	1	-	1	2	1	1	1	1
CO3	2	2	2	2	1	-	1	-	1	-	1	2	1	1	1	1
CO4	2	2	2	2	1	-	1	-	1	-	1	2	1	1	1	1
CO5	1	1	1	2	1	-	1	-	1	-	1	2	1	1	1	1

SEMESTER IV

MA4401	PROBABILITY AND STATISTICS	L	T	P	C
	(Common for all branches of B.E. / B. Tech Programmes)	3	1	0	4

OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two-dimensional random variables.
- To provide necessary basic concepts of probability and random processes for applications in engineering.
- To introduce the basic concepts and important roles in the statistical quality control

UNIT I	PROBABILITY AND RANDOM VARIABLES	9+3
Discrete and continuous random variables – P.d.f, Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.		CO1
UNIT II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**9+3**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables		CO2
UNIT III	**RANDOM PROCESSES**	**9+3**
Classification – Stationary process – Markov process – Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) – Limiting distributions.		CO3
UNIT IV	**NON-PARAMETRIC TESTS**	**9+3**
Introduction – The Sign test – The Signed – Rank test – Rank – sum tests – The U test – The H test – Tests based on Runs – Test of randomness – The Kolmogorov Test.		CO4
UNIT V	**STATISTICAL QUALITY CONTROL**	**9+3**
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling		CO5

TOTAL : 60 HOURS

TEXT BOOKS:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Ibe, O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier,1st Indian Reprint, 2007

REFERENCE BOOKS:

1. Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.

2. Papoulis, A.and Unnikrishnapillai,S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
6. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
CO2	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
CO3	Apply the concept of random processes in engineering disciplines
CO4	Apply the basic concepts of statistical quality control.
CO5	Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	-	-	-	-	-	2	3	-	1	2	1	1	1
CO2	3	2	2	-	-	-	-	-	1	2	-	1	2	1	1	1
CO3	3	3	3	-	-	-	-	-	2	2	-	1	3	3	2	2
CO4	3	2	2	-	-	-	-	-	2	1	-	2	1	1	2	2
CO5	3	3	2	-	-	-	-	-	2	2	-	2	1	2	2	1

EC4402	**SIGNALS AND SYSTEMS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To understand the fundamental properties of signals and systems
- To understand the techniques for characterizing LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I	**INTRODUCTION TO SIGNALS AND SYSTEMS**	**12**
Introduction to Continuous time (CT) and Discrete Time (DT) signals- Elementary operations on independent variables-Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids-Classification of signals — Continuous time and Discrete Time		**CO1**

signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals, Odd & Even signals — Classification of systems- Continuous Time systems and Discrete Time systems- — Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable- Invertible and non-invertible systems.		
UNIT II	**CONTINUOUS TIME SIGNAL ANALYSIS**	**12**
Fourier series for periodic signals –Exponential Fourier series, Trigonometric Fourier Series- Fourier Transform and properties- Laplace Transforms and properties		**CO2**
UNIT III	**ANALYSIS AND DESIGN OF LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS**	**12**
Impulse response - convolution integrals- Differential Equation – Solutions to Differential Equations - Fourier and Laplace transforms in Analysis of Continuous Time systems - Systems connected in series / parallel.		**CO3**
UNIT IV	**DISCRETE TIME SIGNALS ANALYSIS**	**12**
Baseband signal Sampling – Effects of Aliasing – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT – Introduction to Z Transform & Properties.		**CO4**
UNIT V	**ANALYSIS AND DESIGN OF LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**	**12**
Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform - Z Transform Analysis of Recursive & Non-Recursive systems- Discrete Time systems connected in series and parallel.		**CO5**
	Total Hours:	**60**
	TEXTBOOKS	
1.	Allan V.Oppenheim, S.Wilsky and S.H.Nawab, ―Signals and Systems‖, Pearson, 2015.	
2.	Simon Haykin and Barry Van Veen, "Signals & Systems", John Wiley and Sons Inc., 2005	
	REFERENCE BOOKS	
1.	B. P. Lathi, Principles of Linear Systems and Signals‖, Second 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.	P.Ramakrishna Rao, "Signals and Systems", Tata Mc Graw Hill Publications, 2008.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Analyze whether a given system is linear, causal, and stable, and to classify signals.	
CO2	Determine the frequency components present in a deterministic continuous time signal.	
CO3	Characterize Continuous Time - LTI systems in the time domain and frequency domain.	
CO4	Investigate discrete time signals and their transforms.	
CO5	Compute the output of a Discrete Time - LTI system in the time domain and frequency domain.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	-	-	-	-	-	-	2	3	3	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	3	2	1
CO3	3	3	3	1	2	-	-	-	-	-	-	2	3	3	2	1
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3	3	2	1

CO5	3	3	3	1	2	-	-	-	-	-	-	2	3	3	2	1

EC4403	**COMMUNICATION SYSTEMS**	**L**	**T**	**P**	**C**
	(Common to Electronics and Communication Engineering)	**3**	**0**	**0**	**3**

OBJECTIVES:

- To gain knowledge about signals and system and Amplitude Modulation.
- To get in-depth understanding of Angle modulation.
- To gain conceptual understating of random process in communication systems.
- To study the various digital modulation techniques.
- To study the principles behind information theory and coding.

UNIT I	**AMPLITUDE MODULATION**	**9**
Review of signals and systems - Time and Frequency domain representation of signals - Principles of Amplitude Modulation Systems-Amplitude Modulation- DSBSC, DSBFC, SSB, VSB - DSBSC Generation – Balanced and Ring Modulator, SSB Generation – Filter, Phase Shift and Third Methods, VSB Generation – Filter Method, Hilbert Transform, Pre-envelope & complex envelope –comparison of different AM techniques, Superheterodyne Receiver		CO1
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.		CO2
UNIT III	**RANDOM PROCESSING**	**9**
Review of probability and random process - Stationary Processes, Mean, and Correlation & Covariance functions - Power Spectral Density - Ergodic Processes - Gaussian Process - Transmission of a Random Process Through a LTI filter- Noise sources – Noise figure, noise temperature and noise bandwidth - Noise in Frequency modulation systems - Pre-emphasis and De-emphasis - Threshold effect in angle modulation.		CO3
UNIT IV	**DIGITAL TECHNIQUES**	**9**
Low pas sampling theorem – Quantization – PAM – Line coding – PCM, DPCM, DM, and ADPCM and ADM- Phase shift keying – BPSK, DPSK, QPSK – Principles of M-ary signaling M-ary PSK & QAM – Comparison, ISI – Pulse shaping – Duo binary encoding – Cosine filters – Eye pattern, Equalizers.		CO4
UNIT V	**INFORMATION THEORY AND CODING**	**9**
Measure of information – Entropy – Source coding theorem – Shanon–Fano coding, Huffman Coding, LZ Coding – Chanel capacity – Shanon-Hartley law – Shanon's limit – Error control codes – Linear Block codes, Cyclic codes, Syndrome calculation – Convolution Coding, Sequential and Viterbi decoding		CO5
	Total Hours:	45

	TEXTBOOKS
1.	Simon Haykins," Communication Systems", Wiley, 5th Edition, 2009.(Unit I - V)
2.	J.G.Proakis, M.Salehi, ―Fundamentals of Communication Systems‖, Pearson Education 2014.

	REFERENCE BOOKS
1.	Wayner Tomasi, Electronic Communication System, 5th Edition, Pearson Education,2008.
2.	A.Papoulis, "Probability, Random variables and Stochastic Processes", McGraw Hill, 3rd edition, 1991.
3.	Ashutosh Pramanic, "Electromagnetism", Prentice Hall of India , New Delhi, 2006.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Gain knowledge in amplitude modulation techniques.
CO2	Describe and analyze the concept of Angle Modulation.
CO3	Understand the concepts of Random Process to the design of communication systems
CO4	Gain knowledge in digital techniques
CO5	Understand the importance of Information Coding.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	3	3	3	1	-	-	-	-	2	2	3	2	1	1
CO2	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1	2
CO3	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1	2
CO4	3	3	3	3	3	1	-	-	-	-	2	2	3	2	1	2
CO5	3	3	3	3	3	1	-	-	-	-	2	2	3	2	1	2

EC4404	**LINEAR INTEGRATED CIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce IC fabrication and the basic building blocks of linear integrated circuits.
- To familiarize the applications of operational amplifiers.
- To introduce the theory and applications of analog multipliers and PLL.
- To teach the theory of ADC and DAC
- To introduce few special function integrated circuits and waveform generator designs.

UNIT1	**BASICS OF IC FABRICATION AND OPERATIONAL AMPLIFIER**	**9**
Fundamentals of Monolithic IC Technology - Fabrication of a Typical Circuit, Active and Passive Components of IC, Current mirror and current sources, Current sources, Voltage sources, Voltage References, Introduction to op-amps – Ideal Operational Amplifier and its characteristics - General operational amplifier stages - and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations.		

UNIT II	**LINEAR AND NON-LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**9**
Inverting Configuration, Non-Inverting Configuration, Amplifier, Phase Shift Circuits, Buffer Amplifier, V-to-I and I-to-V converters, Summer, Differential Amplifier, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, Clipper and Clamper, Filter Design - First Order and Second Order - High Pass - Low Pass - Band Pass - Butterworth Filter		
UNIT III	**ANALOG MULTIPLIER AND PLL**	**9**
Analog Multiplier using Emitter Coupled Transistor Pair – Single Quadrant - Gilbert Multiplier cell – Variable transconductance technique – Four Quadrant, Analog multiplier applications - Square Rooter - Frequency Divider - Frequency Doubler - Squarer, Operation of the basic PLL, closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, Applications of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing.		
UNIT IV	**A/D AND D/A CONVERTERS**	**9**
Basics of Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current mode - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type – Pipelined Type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.		
UNIT V	**WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS**	**9**
IC 555- internal circuit diagrams, working, Astable and Monostable Multivibrators using 555 Timer, Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Voltage regulators-linear and switched mode types, switched capacitor filter, Frequency to Voltage converters, Tuned amplifiers, Power amplifiers and Isolation Amplifiers, Video and audio amplifiers.		
	Total Hours	45
	TEXTBOOKS	
1.	D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – V)	
2.	Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)	
	REFERENCE BOOKS	
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”, Sixth Edition, PHI, 2001.	

3	S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", TMH,2nd Edition, 4th Reprint, 2016.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand IC Fabrication and OP-AMP design
CO2	Design linear and nonlinear applications of OP – AMPS
CO3	Design applications using analog multiplier and PLL
CO4	Design ADC and DAC using OP – AMPS
CO5	Generate waveforms using OP – AMP Circuits and Analyze special function ICs

MAPPING OF COs WITH POs AND PSOs															
COs	**PROGRAM OUTCOMES (POs)**											**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	3	3	3	2	-	-	-	-	1	2	2	1	1	1
CO2	3	2	2	2	2	1	-	-	-	-	1	2	2	1	1	1
CO3	3	2	2	2	2	1	-	-	-	-	1	1	2	2	1	1
CO4	3	2	2	2	3	1	-	-	-	-	1	1	2	2	1	2
CO5	2	2	3	2	3	2	-	-	-	-	1	1	3	1	1	2

EC4405	**SENSORS AND ACTUATORS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To understand the design concepts of actuators.

UNIT I	**INTRODUCTION**	**9**
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types. Mathematical model of transducer – Zero, I and II order transducers.		CO1
UNIT II	**MOTION, PROXIMITY AND RANGING SENSORS**	**9**
Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR)- Applications of Industrial Engineering.		CO2

UNIT III	**FORCE, MAGNETIC AND HEADING SENSORS**	**9**
Strain Gage, Load Cell, Magnetic Sensors–types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.		CO3
UNIT IV	**OPTICAL, PRESSURE AND TEMPERATURE SENSORS**	**9**
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors – Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors. Applications of Medical Engineering.		CO4
UNIT V	**SENSOR MATERIALS AND ACTUATORS**	**9**
Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, Nano materials. Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles. exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator. Case studies of MEMS in magnetic actuators.		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009	
2.	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.	
	REFERENCE BOOKS	
1	Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi,2002.	
2	Vinod Kumar Khanna, Nanosensors: Physical, Chemical, and Biological, CRC press, First Edition, 2012.	
3	Chang Liu, Foundations of MEMS, Pearson education India limited, Second Edition, 2006.	
4	Ramon Pallás Areny and John G. Webster, Sensors and Signal conditioning, John Wiley and Sons, Second Edition, 2000.	
5	Jack P Holman, Experimental Methods for Engineers, McGraw Hill, USA, Seventh Edition, 2001.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Familiar with various calibration techniques and Mathematical model of signal types for sensors.	
CO2	Apply the various sensors in the Automotive and Mechatronics applications.	
CO3	Describe the working principle and characteristics of force, magnetic and heading sensors.	
CO4	Understand the basic principles of various pressure and temperature, smart sensors.	

CO5	Understand the basic sensor materials and principles of various actuators.

MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3																
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	3	2	2	1	3	2	1	2	3	1	2	2
CO2	3	3	3	2	3	2	2	1	2	2	2	1	2	1	3	3
CO3	3	3	2	2	2	1	2	1	2	1	1	2	2	2	2	2
CO4	3	3	2	2	2	1	1	1	1	1	1	3	3	1	3	3
CO5	3	3	3	3	2	1	2	1	3	1	1	3	3	1	3	3

EC4406	**TRANSMISSION LINES AND RF SYSTEMS**	**L**	**T**	**P**	**C**
	(Common to ECE Departments)	**3**	**0**	**0**	**3**

OBJECTIVES:

- To introduce the general transmission lines and its properties
- To give thorough understanding about high frequency line, power and impedance measurements
- To impart technical knowledge in impedance matching using smith chart
- To introduce passive filters and basic knowledge of active RF components
- To get acquaintance with RF system transceiver design

UNIT I	**TRANSMISSION LINE FUNDAMENTALS**	**9**
Introduction to Transmission lines - general solution of transmission line - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion-less line - Loading and different methods of loading - Line not terminated in Z_0 - Reflection coefficient, reflection factor and reflection loss, - Input and transfer impedance - Open and short circuited lines - S-parameters and its properties.		CO1

UNIT II	**HIGH SPEED TRANSMISSION LINES**	**9**
Transmission line equations at high frequencies - Line of Zero dissipation - Voltage and current on the dissipation-less line, Standing Waves, Standing Wave Ratio - Input impedance of the dissipation-less line - Power and impedance measurement on lines - Reflection losses, Case Studies: Modern Planar Transmission lines, Transmission line for high-speed PCB Layout.		CO2

UNIT III	**IMPEDANCE MATCHING**	**9**
Impedance matching – Impedance matching by Quarter wave transformer and stubs - Single stub and double stub matching - Smith chart - Solutions of problems using Smith chart - Single and double stub matching using Smith chart.		CO3

UNIT IV	**TE,TM AND TEM WAVEGUIDES**	**9**
General Theory of Transverse Electromagnetic Waves, Transverse Magnetic Waves, Transverse Electric Waves – TM and TE Waves between parallel plates. Field Equations of TM and TE waves		CO4

in rectangular waveguides, Bessel Functions, Field Equations of TM and TE waves in Circular waveguides.		
UNIT V	**RF SYSTEM DESIGN**	**9**
RF components design using Semiconductor – BJT, FET – High electron mobility transistors design – RF Mixers, Filter, LNA, VCO – RF Power Amplifier design: transducer power gain and stability considerations.		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	John D Ryder, ―Networks, lines and fields‖, 2nd Edition, Prentice Hall India, 2015. (UNIT I-IV).	
2.	Mathew M. Radmanesh, ―Radio Frequency &Microwave Electronics‖, Pearson Education Asia, Second Edition,2002. (UNIT V)	
	REFERENCE BOOKS	
5.	Reinhold Ludwig and Powel Bretchko,‖ RF Circuit Design – Theory and Applications‖, Pearson Education Asia, First Edition,2001.	
6.	D. K. Misra, ―Radio Frequency and Microwave Communication Circuits- Analysis and Design, John Wiley & Sons, 2004.	
7.	E.C.Jordan and K.G. Balmain, ―Electromagnetic Waves and Radiating Systems Prentice Hall of India, 2006.	
8.	G.S.N Raju, "Electromagnetic Field Theory and Transmission Lines Pearson Education, First edition 2005.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Analyze the line parameters and various losses in transmission lines.	
CO2	Acquire knowledge about high frequency transmission lines used at radio frequencies.	
CO3	Design impedance matching network using smith chart.	
CO4	Using vector calculus to solve Maxwell's equations and analyze the electromagnetic fields in parallel plate waveguides and apply and analyze electromagnetic wave propagation through guiding structures.	
CO5	Acquire basic knowledge of active RF components.	

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	3	2	-	-	-	-	-	1	2	1	1	2

CO2	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1	2
CO3	3	3	3	2	2	1	-	-	-	-	-	1	2	1	1	2
CO4	3	3	2	3	2	1	-	-	-	-	-	1	2	1	2	2
CO5	3	3	3	3	2	1	-	-	-	-	-	2	1	1	2	2

EC4407	**COMMUNICATION SYSTEMS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To visualize the effect of sampling and TDM in a transceiver.
- To implement AM & FM modulation and demodulation.
- To implement Line Coding, PCM & DM.
- To simulate Digital Modulation schemes.
- To simulate Error control coding schemes.

List of Experiments

1. Signal Sampling and reconstruction
2. Time Division Multiplexing
3. AM Modulator and Demodulator
4. FM Modulator and Demodulator
5. Pulse Code Modulation and Demodulation
6. Delta Modulation and Demodulation
7. Line coding schemes
8.a. ASK, FSK, and BPSK Modulators
8. b. Simulation of ASK, FSK, and BPSK generation & detection schemes
9. Simulation of DPSK, QPSK and QAM generation & detection schemes
10. Simulation of signal constellations of BPSK, QPSK and QAM
11. Simulation of Linear Block and Cyclic error control coding schemes
12. Simulation of Convolutional coding scheme
13.Communication link simulation

Total Hours: 60

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Simulate & validate the various functional modules of a communication system.
CO2	Demonstrate their knowledge in base band signaling schemes through implementation of digital modulation schemes.
CO3	Apply various channel coding schemes.
CO4	To study the error performance of various digital modulation schemes.
CO5	To Simulate end-to-end communication Link.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3	
COs	**PROGRAMME OUTCOMES**	**PROGRAMME SPECIFIC OUTCOMES**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO2	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO3	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO4	3	3	3	3	-	1	-	-	-	-	1	3	3	3	2	3
CO5	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3

EC4408	**LINEAR INTEGRATED CIRCUITS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To understand the basics of operational amplifiers, characteristics and circuits construction.
- To apply operational amplifiers in linear and nonlinear applications.
- To construct oscillators for signal generation.
- To acquire the basic knowledge of special function IC.
- To learn simulation software for circuit design.

List of Experiments

1. Inverting, Non inverting and differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier
4. Active low-pass, High-pass and band-pass filters.
5. Astable & Monostable multivibrators using Op-amp
6. Clippers and Clampers
7. Attenuators and Buffer Amplifiers
8. Schmitt Trigger using Op-amp.
9. Phase shift and Wien bridge oscillators using Op-amp.
10. Hartley Oscillator and Colpitts Oscillator using Op-Amp.
11. Astable and Monostable multivibrators using NE555 Timer.
12. Analyse the operation of IC565 PLL.
13. Multi-Waveform Generator
14. R-2R Ladder Type D- A Converter using Op-amp.
15. DC power supply using LM317 and LM723.
16. Study of SMPS.

Simulation Experiments

1. Active low-pass, High-pass and band-pass filters using Op-amp.
2. Astable and Monostable multivibrators using NE555 Timer.
3. A/D Converter.
4. D/A Converter.

Total Hours: 60

COURSE OUTCOMES:

After completing this course, the students will be able to

CO1	Design amplifiers, oscillators, multivibrators D-A converters using operational amplifiers.
CO2	Design filters using op-amp and performs an experiment on frequency response.
CO3	Design signal conditioning and shaping circuits.
CO4	Design DC power supply using ICs.
CO5	Analyze the performance of filters, multivibrators, A/D converter and D/A converter using SPICE.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO2	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO3	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3
CO4	3	3	3	3	-	1	-	-	-	-	1	3	3	3	2	3
CO5	3	3	3	3	3	1	-	-	-	-	1	3	3	3	2	3

SEMESTER V

EC4501	**DISCRETE TIME SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To study the concepts discrete Fourier transform, properties of DFT and its application to linear filtering
- To understand the characteristics of IIR filters and apply these filters to filter undesirable signals in various frequency bands
- To understand the characteristics of FIR filters and apply these filters to filter undesirable signals in various frequency bands
- To understand the Finite word length effects in digital filters.
- To know the fundamental concepts of multi rate signal processing and its applications
- To understand the concepts of adaptive filters and its application to communication engineering

UNIT I	**DISCRETE FOURIER TRANSFORM**	**9**
Review of signals and systems, concept of frequency in discrete-time signals, Discrete Fourier transform (DFT) - DFT as a linear transformation, properties of DFT - periodicity, linearity, time-reversal, symmetry, multiplication, circular convolution. Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method. Computation of DFT using DIT-FFT and DIF-FFT.		**CO1**

UNIT II	**FINITE IMPULSE RESPONSE FILTERS**	**9**
FIR filter structures - linear phase structure, direct form realizations, Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method.		**CO2**
UNIT III	**INFINITE IMPULSE RESPONSE FILTERS**	**9**
Design of analog filters - Chebyshev filter, Butterworth filter. Design of digital IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Realization structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.		**CO3**
UNIT IV	**FINITE WORD LENGTH EFFECTS**	**9**
Binary fixed point and floating-point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.		**CO4**
UNIT V	**MULTI RATE SIGNAL PROCESSING AND DSP PROCESSORS**	**9**
Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor Adaptive Filters: Introduction, Applications of adaptive filtering to equalization. DSP Architecture- Fixed- and Floating-point architecture principles.		**CO5**
Total Hours:		**45**
Tutorial Hours		**15**

	TEXTBOOKS
1.	John G. Proakis and Dimitris G.Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2.	A. V. Oppenheim, R.W. Schafer and J.R. Buck, ―Discrete-Time Signal Processing‖, 8th Indian Reprint, Pearson, 2004.
	REFERENCE BOOKS
1.	Emmanuel C. Ifeachor & Barrie. W. Jervis, "Digital Signal Processing", Second Edition, Pearson Education / Prentice Hall, 2002.
2.	Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill, 2007.
3.	Andreas Antoniou, "Digital Signal Processing", Tata Mc Graw Hill, 2006.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Analyze the signal performance in frequency domain using Discrete Fourier transform, FFT and also gathers knowledge about convolution with the help of linear filtering.
CO2	Design finite impulse response (FIR) filters using different techniques and also investigate its structure realization.
CO3	Design infinite impulse response (IIR) filters using different transformation techniques and also investigate its structure realization.
CO4	Analyze finite word length effects for real time implementation and also gathers knowledge about number representation.
CO5	Analyze the architecture of digital signal fixed and floating-point processors and Apply adaptive filters appropriately in communication systems.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	1	2	-	-	-	-	2	2	2	2	1	1
CO2	3	3	3	3	1	2	-	-	-	-	2	2	3	2	1	1
CO3	3	3	3	3	1	2	-	-	-	-	2	2	3	2	1	1
CO4	3	3	3	3	1	2	-	-	-	-	2	2	2	2	1	1
CO5	3	2	2	2	2	2	-	-	-	-	1	2	2	3	1	1

EC4502	**VLSI DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Study the fundamentals of CMOS circuits and its characteristics.
- Learn the design and realization of combinational & sequential digital circuits.
- Analyze Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology.
- Learn the different FPGA architectures and testability of VLSI circuits.

UNIT I	**FUNDAMENTALS OF CMOS CIRCUITS**	**9**
CMOS logic, Inverter, NAND gate, NOR Gate, Compound Gates, Layout - Design Rules, Stick Diagrams, MOS Transistor - Ideal I-V Characteristics, C-V Characteristics, short channel effects, Complementary CMOS inverter DC Transfer characteristics, Inverter Delay and Logical Effort, Scaling		**CO1**
UNIT II	**DESIGN OF LOGIC CIRCUITS**	**9**
Combinational circuit design - Static CMOS, Ratioed Circuits, Pass Transistors, Transmission Gates, Cascode Voltage Switch Logic, Dynamic Circuits- Domino Logic, Dual Rail Domino Logic, CPL, DCVSPG, DPL, Static and dynamic - latches and flip flops, Dynamic Power and Static Power Dissipation		**CO2**
UNIT III	**ARITHMETIC BUILDING BLOCKS DESIGN**	**9**
Design of Adders- Static adder- Ripple carry , Mirror Adder , Carry Look ahead Adder,Carry save adder, Carry skip adder, Multipliers- Array multiplier, Fast multipliers- Booths and Modified Booths Multiplier, Wallace tree multiplier, Divider – serial and parallel, Barrel Shifter, Logarithmic Shifter		**CO3**
UNIT IV	**MEMORY DESIGN**	**9**
Designing Memory and Array structures: Memory Architectures and Building Blocks- OR ROM, NOR ROM, NAND ROM cell array, 6 T SRAM cell, 3 T DRAM Cell, Memory Peripheral Circuitry – Address Decoders, Sense Amplifiers, Power Dissipation in memories		**CO4**
UNIT V	**PROGRAMMABLE LOGIC ARCHITECTURES AND TESTING**	**9**

ASIC design flow, FPGA Building Block Architectures, FPGA Interconnect Routing Procedures, VLSI testing, Design for Testability, Design for Manufacturability	**CO5**
Total Hours	**45**

TEXT BOOKS

1. Neil H.E. Weste, David Money Harris "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson , 2017 (UNIT I,II,V)
2. Jan M. Rabaey ,Anantha Chandrakasan, Borivoje. Nikolic, "Digital Integrated Circuits: A Design perspective", Second Edition , Pearson , 2016.(UNIT III,IV)

REFERENCE BOOKS

1. M.J. Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997
2. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim "CMOS Digital Integrated Circuits: Analysis & Design",4th edition McGraw Hill Education,2013
3. Wayne Wolf, "Modern VLSI Design: System On Chip", Pearson Education, 2007
4. R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", Prentice Hall of India 2005.

CO	COURSE OUTCOMES:
CO1	Realize the concepts of digital building blocks using MOS transistor.
CO2	Design MOS Logic circuits and power strategies.
CO3	Design arithmetic building blocks .
CO4	Design memory subsystems.
CO5	Apply and implement FPGA design flow and testing.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	2	1	2	-	-	-	-	2	2	2	3	3	1
CO 2	3	3	2	2	1	2	-	-	-	-	2	2	2	3	3	1
CO 3	2	3	2	2	1	2	-	-	-	-	2	2	2	3	3	1
CO 4	3	2	2	2	1	2	-	-	-	-	2	2	2	3	3	1
CO 5	3	2	2	2	1	2	-	-	-	-	2	2	2	3	3	1

EC4508	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To introduce the relevance of this course to the existing technology through demonstration simulations
- To learn the Hardware Description Language -Verilog
- To learn the principles of VLSI circuit design in digital and analog domain
- To familiarize fusing of logical modules on FPGAs

Part I: Digital System Design using HDL & FPGA

1. Design a half adder and full adder using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA

2. Design an 12 bit Ripple carry Adder using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 3. Design a 4 bit shift and add multiplier and booths Multiplier using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 4. Design an Arithmetic Logic Unit using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 5. Design a Universal Shift Register using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 6. Design Moore/Mealy finite state machine using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 7. Design Memories using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA 8. Compare pre synthesis and post synthesis simulation for experiments 1 to 6. Requirements: Xilinx ISE/Altera Quartus/ equivalent EDA Tools along with Xilinx/Altera/equivalent FPGA Boards
Part-II Digital Circuit Design
9. Simulate a CMOS inverter using digital design flow 10. Simulate T and D Flip-Flops using digital design flow 11. Design and simulate a 4-bit synchronous counter using digital design flow
Part-III Analog Circuit Design
12**.** Design and Simulate universal gates using CMOS. 13. Design and Simulate a CMOS Inverting Amplifier. 14. Design and Simulate basic Common Source, Common Gate and Common Drain Amplifiers. Analyze the input impedance, output impedance, gain and bandwidth for experiments 10 and 11 by performing Schematic Simulations. 15. Design and simulate simple 5 transistor differential amplifier. Analyze Gain, Bandwidth and CMRR by performing Schematic Simulations

Total Hours:	**60**

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Realize the concepts of digital design system using HDL and FPGA.
CO2	Realize the concepts of digital design system using HDL and FPGA.
CO3	Design Digital circuits using HDL
CO4	Design and Simulate Analog circuits
CO5	Design and Simulate Analog circuits

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	1	2	-	-	-	-	-	-	-	2	2	2	1
CO2	3	2	3	1	2	-	-	-	-	-	-	-	2	2	2	1
CO3	3	2	3	1	2	-	-	-	-	-	-	-	2	2	2	1
CO4	3	2	3	1	2	-	-	-	-	-	-	-	2	2	2	1
CO5	3	2	3	1	2	-	-	-	-	-	-	-	2	2	2	1

EC4509	DIGITAL SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

The student should be made:

- To perform basic signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation and Frequency analysis in MATLAB
- To study the architecture of DSP processor
- To implement FIR and IIR filters in MATLAB and DSP Processor
- To implement up-sampling and down-sampling in MATLAB and DSP Processor

LIST OF EXPERIMENTS: MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Generation of elementary Continuous-Time and Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering Operations
7. Multirate signal processing (up-sampling and down sampling)

DSP PROCESSOR BASED IMPLEMENTATION

1. Study of architecture of Digital Signal Processor
2. Perform MAC operation using various addressing modes
3. Linear convolution
4. Circular convolution
5. Design and demonstration of FIR Filter for Low pass, High pass, Bandpass and Bandstop filtering
6. Design and demonstration of IIR Filters for Low pass,High pass, Band pass and Band stop filtering
7. Implement an Up-sampling and Down-sampling operation in DSP Processor waveform generation

TOTAL: 60 Hours

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	2	-	-	-	-	2	2	3	3	2	3
CO2	3	3	3	3	2	2	-	-	-	-	2	2	2	2	2	3
CO3	3	3	3	3	2	2	-	-	-	-	2	2	1	2	3	3
CO4	3	3	3	2	3	2	-	-	-	-	1	2	2	1	2	3
CO5	3	2	2	2	3	2	-	-	-	-	1	2	2	2	1	3

SEMESTER VI

EC4651	EMBEDDED SYSTEMS AND IoT SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide students with good depth of knowledge of Designing Embedded and IoT Systems forvarious application
- To understand the design of a IoT system
- Knowledge for the design and analysis of Embedded and IoT Systems for Electronics Engineering students

UNIT1	INTRODUCTION TO EMBEDDED SYSTEMS	9
Introduction to Embedded Systems and Elements of embedded Systems, Classification of an Embedded system. Structural units in Embedded processor. Memory management methods, Comparison of General-purpose computers vs embedded system, Embedded System Design Process, Design example: Model train controller- Design methodologies- Design flows.		
UNIT II	**HARDWARE DESIGN FOR EMBEDDED SYSTEMS:**	**9**
Microcontrollers for embedded systems, Introduction to ARM Processors, ARM architectural details, The ARM programmer's model, ARM development tools, Block Diagram of ARM9 and ARM Cortex M3 MCU. Peripheral Interfacing with ARM. Basic Wire and Wireless Protocols like, UART, I2C, SPI.		
UNIT III	**EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT AND EMBEDDED OPERATING SYSTEMS**	**9**
Embedded Product Development Life Cycle- objectives, different phases of EDLC Operating system requirements for Embedded systems, Fundamentals of Real Time Operating System (RTOS), Operating system services, Process, Task and Thread, System calls, Timer and Event Function, Memory management, File and I/O subsystem management, Device Management, Device driver programming.		
UNIT IV	**INTRODUCTION TO IoT BASED EMBEDDED SYSTEMS**	**9**
Introduction to the concept of IoT, Basic architecture of an IoT based Embedded Systems, Physical design - protocols – Logical design of Embedded Hardware for IoT applications, IoT Design Methodology – Specifications Integration and Application Development		
UNIT V	**APPLICATIONS OF IoT BASED EMBEDDED SYSTEMS**	**9**
Home automation – Cities: Smart parking – Environment: Weather monitoring – Agriculture: Smart irrigation – Data analytics for IoT – Software & management tools for IoT cloud storage models & Communication APIs – Cloud for IoT – Amazon Web Services for IoT.		
	Total Hours:	**45**

	TEXTBOOKS
1.	Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2012.
2.	Muhammad Ali Mazidi,Shujen Chen, Sepehr Naimi,Sarmad Naimi, "Embedded ProgrammingUsing C Language", 1st Edition, Freescale ARM Cortex-M

	REFERENCE BOOKS
1. 2.	Rajkamal, "Embedded System: Architecture, Programming and Design", TMH3. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publisher
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Knowledge of theory and practice related to Embedded and IOT System.
CO2	Ability to identify, formulate and solve engineering problems by using Embedded Systemswith IoT.
CO3	Ability to implement real field problem by gained knowledge of Embedded Systems with IoTcapability.
CO4	Understand the OS based software Development of embedded systems.
CO5	To study the various introduction of IOT based embedded systems

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	3	-	-	-	-	2	2	3	3	2	1
CO2	2	3	2	2	3	3	-	-	-	-	2	2	3	3	2	2
CO3	3	2	2	2	3	3	-	-	-	-	2	2	3	3	2	1
CO4	3	1	2	2	3	3	-	-	-	-	2	2	3	3	2	2
CO5	3	1	2	2	3	3	-	-	-	-	1	2	3	2	2	2

EC4602	**WIRELESS COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To study the characteristic of wireless channel
- To understand the design of a cellular system
- To study the various digital signaling techniques and multipath mitigation techniques
- To understand the concepts of MIMO techniques

UNIT I	**WIRELESS PROPAGATION CHANNELS**	**9**
Straits of Wireless Communication- Path loss models: Free Space and Two-Ray models - large scale path loss – Analysis of Link Budget design – Small scale fading- Parameters of mobile multipath channels, Brewster angle – Time dispersion parameters-Coherence bandwidth – Doppler spectra & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Temporal spread – fast fading – slow fading.		

UNIT II	CELLULAR ARCHITECTURE	9
Multiple Access techniques - FDMA, TDMA, CDMA,SDMA, Packet radio - Applications – Capacity calculations, Cellular concepts- Frequency reuse - channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement. Evolution of Cellular Networks		
UNIT III	**SIGNALING TECHNIQUES FOR FADING CHANNELS**	**9**
Elements of a wireless communication link, working of different Signaling Schemes-Offset-QPSK,□/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR,ICI, Adaptive Modulation.		
UNIT IV	**MULTIPATH MITIGATION TECHNIQUES**	**9**
Multipath Mitigation techniques – Overview- Equalization: – Adaptive equalization, Linear and Non-Linear equalization, Algorithms for equalization -Zero forcing and LMS Algorithms. Diversity: – Principle, Micro and Macro diversity, Transmit Diversity, Correlation Coefficient, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.		
UNIT V	**MIMO TECHNIQUES**	**9**
MIMO systems- Types – spatial multiplexing -System model- Channel state information - capacity in fading and non-fading channels – Impact of Channel Diversity - Beam forming - transmitter diversity, receiver diversity -- Multiuser MIMO - Linear Pre-coding.-Alamouti coding scheme		
	Total Hours:	**45**

	TEXT BOOKS
1.	Rappaport,T.S., ―Wireless communications, Pearson Education, Second Edition, 2010. (UNIT I, II, IV)
2.	Andreas.F. Molisch, ―Wireless Communications, John Wiley – India, 2006. (UNIT III,V)
	REFERENCE BOOKS
1.	Wireless Communication –Andrea Goldsmith, Cambridge University Press, 2011
2.	Van Nee, R. and Ramji Prasad, ―OFDM for wireless multimedia communications, Artech House, 2000
3.	David Tse and Pramod Viswanath, ―Fundamentals of Wireless Communication, Cambridge University Press, 2005.
4.	Upena Dalal, ―Wireless Communication, Oxford University Press, 2009.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	To Model a wireless channel and evolve the system design specifications
CO2	Design a cellular system based on resource availability and traffic demands
CO3	Explore an suitable signaling for the wireless channels and systems.
CO4	Identify suitable multipath mitigation techniques for the wireless channels and systems
CO5	Understand the importance of MIMO techniques

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	1	2	-	-	-	-	2	1	3	2	1	1
CO2	3	3	2	2	1	2	-	-	-	-	2	1	3	2	1	1
CO3	3	3	2	2	1	2	-	-	-	-	2	1	3	2	1	1

CO4	3	3	2	2	2	2	-	-	-	-	2	2	3	2	1	1
CO5	3	3	2	2	2	2	-	-	-	-	2	2	3	2	1	1

EC4608	**EMBEDDED and IoT LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- Learn the working of ARM processor
- Understand the Building Blocks of Embedded Systems
- Learn the concept of memory map and memory interface
- To Write programs to interface memory, I/Os with processor.
- Study the interrupt performance

UNIT1	**LIST OF EXPERIMENTS**	

1. Study of ARM evaluation system
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDS.
10. Interfacing stepper motor and temperature sensor.
11. Implementing zigbee protocol with ARM. Explore different communication methods with IoT devices
12. Develop simple application – testing infrared sensor – IoT Applications – using Aurdino
13. Develop simple application – testing temperature, light sensor – IOT Application -using open platform/Raspberry Pi.
14. Deploy IOT applications using platforms such as Bluemix / Think Speak / Firebase.

	Total Hours: 60
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Learn the working of ARM processor
CO2	Understand the Building Blocks of Embedded Systems
CO3	Learn the concept of memory map and memory interface
CO4	To Write programs to interface memory, I/Os with processor..
CO5	Develop IoT applications using Arduino/Raspberry Pi/open platform.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**

CO1	3	2	3	1	2	1	-	-	-	-	1	3	2	3	2	2
CO2	3	2	3	1	2	1	-	-	-	-	1	3	2	3	2	2
CO3	3	2	2	1	2	1	-	-	-	-	1	3	2	3	2	2
CO4	3	1	2	2	2	1	-	-	-	-	1	2	2	3	2	2
CO5	3	1	1	2	2	1	-	-	-	-	1	3	2	3	1	2

EC4609	**MINI PROJECT**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

• To develop their own innovative prototype of ideas.
• To train the students in preparing mini project reports and examination.

The students in a group of 4 to 5 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. 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 mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 HOURS

OUTCOMES:

• On Completion of the mini project work students will be in a position to take up their final year project work and find solution by formulating proper methodology.

SEMESTER VII

GE4791	**HUMAN VALUES AND ETHICS**	**L**	**T**	**P**	**C**
Common to ECE and Mech		3	0	0	3

OBJECTIVES

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I	**HUMAN VALUES**	**10**
Morals, values, and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.		**CO1**

UNIT II	**ENGINEERING ETHICS**	**9**
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		**CO2**
UNIT III	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9**
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.		**CO3**
UNIT IV	**SAFETY, RESPONSIBILITIES AND RIGHTS**	**9**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.		**CO4**
UNIT V	**GLOBAL ISSUES**	**8**
Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.		**CO5**
	Total Hours:	**45**

	TEXTBOOKS
1.	Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2.	Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
	REFERENCE BOOKS
1.	Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2.	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3.	John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4.	Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
5.	Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6.	World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Students should be able to apply ethics in society, and realize the responsibilities and rights in the society.
CO2	Students should be able to discuss the ethical issues related to engineering
CO3	Understood the core values that shape the ethical behaviour of an engineer
CO4	Exposed awareness on professional ethics and human values
CO5	Known their role in technological development

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	2	2	3	2	-	-	1	-	-	-	3
CO2	-	-	-	-	-	2	2	3	2	-	-	1	-	-	-	3
CO3	-	-	-	-	-	2	2	3	2	-	-	1	-	-	-	3
CO4	-	-	-	-	-	2	2	3	2	-	-	1	-	-	-	3
CO5	-	-	-	-	-	2	2	3	2	-	-	1	-	-	-	3

EC4702	**MICROWAVE and OPTICAL COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

- **OBJECTIVES:**
- To Realize basic elements in optical fibers, different modes and configurations.
- To Analyze the transmission characteristics associated with dispersion and polarization techniques.
- To Facilitate the knowledge about optical fiber sources and transmission techniques
- To Explore the trends of optical fiber measurement systems.
- To enhance the student knowledge in the area of microwave components for practical applications.

UNIT I	**OPTICAL WAVEGUIDE**	**9**
Overview- Elements of Optical Fiber Communication link - Optical Fibers- Nature of light propagation – Optical laws – Ray theory, Total Internal Reflection - Optical Fiber – Classification- Step Index, Graded Index, Optical Modes and Configuration– Mode theory of circular waveguides – Fiber materials – Techniques of Fiber Fabrication – Fiber optic cables		**CO1**
UNIT II	**SIGNAL PROPAGATION EFFECTS IN FIBER**	**9**
Attenuation - Absorption losses, scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in optical fiber -Group Delay-Material Dispersion, Waveguide Dispersion-Calculation of Information Capacity, Signal impairments in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Design Optimization of SM fibers-RI profile and cut-off wavelength, Pulse Broadening in GI fibers-Mode Coupling.		**CO2**
UNIT III	**LIGHT SOURCES AND DETECTORS**	**9**
Sources: Intrinsic and extrinsic material-direct, indirect band gaps materials-Light Source-Type--LED structures, surface emitting LED-Edge emitting LED-quantum efficiency and LED power-light source materials-modulation of LED LASER diodes:-modes and threshold conditions-Rate equations-external quantum efficiency-resonant frequencies-structures and radiation patterns-single mode laser-external modulation-temperature effort. **Detectors:** PIN photo detector-Avalanche photo diodes-Photo detector noise-noise sources-SNR-detector response time-Avalanche multiplication noise- Performance comparison of photo detectors.		**CO3**
UNIT IV	**FIBER OPTIC RECEIVER AND MEASUREMENTS**	**9**

Preamplifiers- Operation of optical receiver, Error sources – Receiver Configuration– Probability of Error – Quantum limit., Coupling Techniques, WDM, SONET/ SDH, Fiber Numerical Aperture Measurements - Dispersion measurements – Fiber Refractive index profile measurements – Fiber cut-off Wavelength Measurements – Fiber Attenuation measurements- Fiber diameter measurements.		**CO4**
UNIT V	**PASSIVE AND ACTIVE MICROWAVE DEVICES**	**9**
Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes, Microwave tubes: Klystron, TWT, Magnetron.		**CO5**
	Total Hours:	45

	TEXT BOOKS
1.	Gerd Keiser, "Optical Fiber Communication" Mc Graw -Hill International, 4th Edition.2010.
2	David M. Pozar, "Microwave Engineering", Fourth Edition, Wiley India,2012. (UNIT V)
	REFERENCE BOOKS
1.	John M. Senior , “Optical Fiber Communication”, Second Edition, Pearson Education, 2007.
2.	J.Gower, "Optical Communication System", Prentice Hall of India, 2001.
3.	Govind P. Agrawal, “Fiber-optic communication systems”, third edition, John Wiley, 2004.
4.	P Chakrabarti, "Optical Fiber Communication”, McGraw Hill Education (India) Private Limited, 2016 (UNIT I, II, III)
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basic elements in optical communication- fibers, different modes and configurations.
CO2	Analyze the transmission characteristics associated with dispersion and polarization techniques.
CO3	Design optical sources and detectors with their use in optical communication system.
CO4	Evaluate fiber optic receiver systems, measurements and coupling techniques.
CO5	Understand the working of passive and active microwave devices

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	3	2	2	2	1	-	-	-	-	-	1	2	1	2	1
CO2	3	3	2	2	2	1	-	-	-	-	-	1	2	1	2	2
CO3	3	3	2	3	3	1	-	-	-	-	-	1	3	1	2	1
CO4	3	3	2	3	3	1	-	-	-	-	-	1	2	2	2	2
CO5	3	3	2	3	3	1	-	-	-	-	-	3	3	2	2	1

EC4703	**FIELD AND SERVICE ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To Understand the fundamentals of robotics
- To Understand the robot kinematics
- To familiarize the concept on path planning in robotics
- To understand field robotics
- Explore on robotics control and applications

UNIT I	**FUNDAMENTALS OF ROBOTICS**	**9**
Definition and laws of robotics - History of service robotics - anatomy of robot - robot classifications- Need for service robots - specifications and configurations - links and joints - examples of service and field Robots		
UNIT II	**KINEMATICS**	**9**
Robot architecture - pose of a rigid body - coordinate transformation - homogenous coordinates - Denavit and Hartenborg (DH) parameters - forward position analysis - inverse position analysis – Localization: Challenges –Mapping - Probabilistic Map - Monte carlo localization -Globally unique localization- Positioning beacon systems- Route based localization		
UNIT III	**PATH PLANNING**	**9**
Path planning overview- Road map path planning- Cell decomposition path Planning-Potential field path planning-Obstacle avoidance - trajectory planning - joint interrelated trajectories - Cartesian path trajectories - Point to point vs continuous path planning		
UNIT IV	**FIELD ROBOTICS**	**9**
Operator interface - Mobility or locomotion - Manipulators & Effectors – Programming: - Sensing & Perception: Sensors for Mobile Robots - Sensor classification - Characterizing sensor performance - Inertial Measurement Unit (IMU)		
UNIT V	**ROBOTICS CONTROL AND APPLICATIONS**	**9**
Single axis and Multi axis PID control- PD gravity control, computed torque control - Simulation of simple robot-control system-Matlab programming for control of robots– Safety and robustness - Wheeled and legged: locomotion and balance - Arm movement - Gaze and auditory orientation control - Sound and speech recognition - Motion sensing - - Unmanned aerial vehicles (UAVs) - Basic Aerodynamics - Stability and Control - Case studies		
	Total Hours:	45

	TEXTBOOKS
1.	Robert. J. Schilling, “Fundamentals of robotics – Analysis and control”, Prentice Hall of India 1996
2.	John. J. Craig, “Introduction to Robotics (Mechanics and control)”, Pearson Education Asia 2002.
	REFERENCE BOOKS
1.	Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA, 2004
2.	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
3.	Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011
4.	R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi, 2003.
5.	Paul G. Fahlstrom, Thomas J.Gleason,“Introduction to UAV Systems”,Wiley,4th Edition,2012
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the anatomy, specifications and types of Robots
CO2	Understand the forward and inverse kinematic models of robotic manipulators

CO3	Examine the plan trajectories in joint space & cartesian space and avoid obstacles while robots are in motion
CO4	Attribute the dynamic model and design the controller for robotic manipulators
CO5	Choose appropriate Robotic configuration and sensor for robots used in different applications

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	2	-	-	-	-	1	2	3	2	2	2
CO2	3	3	3	3	2	3	-	-	-	-	1	2	3	3	3	2
CO3	3	3	3	3	2	3	-	-	-	-	1	2	3	3	3	2
CO4	3	3	3	3	3	3	1	-	-	-	2	3	3	3	3	2
CO5	3	3	3	3	3	3	1	-	-	-	2	3	3	3	3	2

EC4706	**ADVANCED COMMUNICATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- Understand the working principle of optical sources, detector, fibers
- Develop understanding of simple optical communication link
- Understand the measurement of BER, Pulse broadening
- Understand and capture an experimental approach to digital wireless communication
- Understand actual communication waveforms that will be sent and received across wireless channel

PART I: LIST OF OPTICAL EXPERIMENTS	
1. Measurement of connector, bending and fiber attenuation losses. 2. Numerical Aperture and Mode Characteristics of Fibers. 3. DC Characteristics of LED and PIN Photo diode. 4. Fiber optic Analog and Digital Link Characterization - frequency response(analog), eye diagram and BER (digital)	CO1 CO2
PART-II LIST OF WIRELESS COMMUNICATION EXPERIMENTS	
5. Analysis of Rician fading channel using simulation 6. Analysis of Rayleigh fading channel using simulation 7. Adaptive equalizer 8. OFDM signal transmission and reception using Software Defined Radios	CO3
PART-III LIST OF MICROWAVE EXPERIMENTS	
9. Gunn Oscillator Characteristics 10. Measurement of VSWR, frequency and wavelength. 11. Performance characteristics of Directional coupler. 12. Performance Measures of Isolator and Circulator.	CO4 CO5
Total Hours:	60

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS, 2 STUDENTS / EXPERIMENT	
1.	Trainer kit for carrying out LED and PIN diode characteristics, Digital multi meter, optical power meter 2 Nos
2.	Trainer kit for determining the mode characteristics, losses in optical fiber 2 Nos
3.	Trainer kit for analyzing Analog and Digital link performance, 2 Mbps PRBS Data source, 10 MHz signal generator, 20 MHz Digital storage Oscilloscope 2 Nos
4	Kit for measuring Numerical aperture and Attenuation of fiber 2 Nos
5.	Advanced Optical fiber trainer kit for PC to PC communication, BER Measurement, Pulse broadening. 2 Nos
6.	MM/SM Glass and plastic fiber patch chords with ST/SC/E2000 connectors 2 sets
7.	LEDs with ST / SC / E2000 receptacles – 650 / 850nm 2 sets
8.	PIN PDs with ST / SC / E2000 receptacles – 650 /850 nm 2 sets
9.	Digital Communications Teaching Bundle (LabVIEW/MATLAB/Equivalent software tools) 10 Users
10.	Software Define Radio Transceiver Platform with antennas and accessories 2 Nos
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Analyze the performance of simple optical link by measurement of losses and Analyzing the mode characteristics of fiber
CO2	Analyze the Eye Pattern, Pulse broadening of optical fiber and the impact on BER
CO3	Estimate the Wireless Channel Characteristics and Analyze the performance of Wireless Communication System
CO4	Analyzing signal transmission in SDR
CO5	Understand the intricacies in Microwave System design

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	2
CO2	3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	2
CO3	3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	2
CO4	3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	2
CO5	3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	2

EC4707	**ROBOTICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To learn the logics of Degrees of Freedom with path planner trajectories.
- Explore into modeling for kinematic and dynamic verification of robot.
- To design and analysis of grippers and to execute the sensor integration for the given robotic application.
- To Develop Logical programming and Interfacing robot

Part I: Degrees of Freedom with path planner trajectories

1. Demonstration of robot with 6 Degrees of Freedom for pick and place application	CO1
2. Execute the 3R planar for the given robotic links	CO2

3. Implement Cartesian path trajectories 4. Develop logical programming for robot path planning (black line and white line follower	
Part-II Modelling and Analysis	
5. Virtual modeling for kinematic and dynamic verification any one robotic structure using MATLAB 6. Design, modeling and analysis of two different types of grippers. 7. Execute the sensor integration for the given robotic application	CO3 CO4
Part-III Develop Logical programming and Interfacing robot	
8. Demonstration of Articulated/ SCARA robot 9. Configure different logical programming for obstacle following and avoiding robot. 10. Design of self balancing Robot using PID control algorithm. 11. Design of Unmanned aerial vehicles (UAVs)	CO5
Total Hours:	60

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Execute logics for 6 Degrees of Freedom pick and place and3R planar 3R planar robotic links
CO2	Implement Cartesian path trajectories and for robot path planning
CO3	Examine modeling for kinematic and dynamic verification of robot
CO4	Perform logical programming for obstacle following and avoiding robot using sensors grippers
CO5	Develop Articulated/ SCARA Robot, UAV and self-balancing Robot using PID control algorithm

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO2	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO3	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO4	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO5	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1

EC4803	**PROJECT WORK**	**L**	**T**	**P**	**C**
		0	**0**	**20**	**10**

OBJECTIVES:

The student should be made:

- To learn how to address problems from identifying them and conducting appropriate research to delivering feasible, effective solutions.
- To provide creative, cost-effective solutions to societal problems.
- To prepare for reviews and oral examinations.

Guidelines

The students may be divided into groups of one or two, work under the supervision of a project supervisor, and compile a full project report after the supervisor is satisfied with their performance. Minimum of four reviews and two model reviews are used to evaluate the project's advancement. The Head of the department may establish the review committee. A project report is needed at the semester's conclusion. The external and internal examiners are appointed to evaluate the project work and the evaluation is based on the oral presentation and the project report.	
Stage 1: Determining the problem: i) A description of the planned system and process specifications must be formulated along with Block Diagram or Functional Diagram. ii) List of potential solutions, including alternatives and limits must be presented iii) Cost-benefit evaluation	CO1 CO2
Stage 2: A presentation is shown, which includes the following: i) The Execution Phase ii) Validation and Testing of the Developed System iii) Unified report preparation	CO3 CO4
Stage 3: A report outlining the completed design based on standards and functional needs.	CO5
Total Hours:	**200**

	COURSE OUTCOMES: After completing their project work, student will be prepared to
CO1	Comprehend an industrial or real-world problem and identify the correct/real problem with a solution.
CO2	Analyze the required literature that carried out in the past years to understand the solutions suggested by different researchers.
CO3	Construct the equipment setup that produces the optimal solution.
CO4	Conclude the analysis with the necessary equations and block diagrams.
CO5	Create a report on the project based on the results.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO2	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO3	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO4	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1
CO5	3	3	3	3	3	-	-	-	1	-	1	2	3	3	3	1

VERTICAL -1

EC4511	**RADAR TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To explore the concepts of radar and its frequency bands.

- To understand Doppler effect and get acquainted with the working principles of CW radar,FM-CW radar.
- To impart the knowledge of functioning of MTI and Tracking Radars.
- To explain the deigning of a Matched Filter in radar receivers.

UNIT1	**INTRODUCTION TO RADAR**	**9**
Basics of Radar: Maximum Unambiguous Range, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation. Radar Equation: SNR, Envelope Detector – False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment).		
UNIT II	**CW AND FREQUENCY MODULATED RADAR**	**9**
Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar.FM-CW Radar: Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter.		
UNIT III	**MTI AND PULSE DOPPLER RADAR**	**9**
Principle, MTI Radar – Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar.		
UNIT IV	**TRACKING RADAR**	**9**
Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.		
UNIT V	**RADAR TRANSMITTERS AND RECIEVERS**	**9**
Detection of Radar Signals in Noise Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross-correlation Receiver, Efficiency of Non-matched Filters, Matched Filter with Non-white Noise. Radar Receivers – Noise Figure and Noise Temperature, Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Applications, Advantages and Limitations.		
	Total Hours:	45

	TEXTBOOKS
1.	Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2ndEd., 2007.
2.	Radar: Principles, Technology, Applications – Byron Edde, Pearson Education, 2004.
	REFERENCE BOOKS
1.	Radar Principles – Peebles, Jr., P.Z., Wiley, New York, 1998
2.	Principles of Modern Radar: Basic Principles – Mark A. Richards, James A. Scheer, William A. Holm, Yesdee, 2013
3.	Radar Handbook Merrill I. Skolnik, 3rd Ed., McGraw Hill Education, 2008.

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basics of Radar and derive the complete radar range equatio
CO2	Understand the need and functioning of CW, FM-CW radars
CO3	Know about MTI and Pulse Doppler Radar
CO4	Analyze the various Tracking methods.

CO5	To study the transmitter design and receiver design of Radars.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	1	2	-	-	-	-	1	2	2	2	2	1
CO2	3	3	3	3	2	2	-	-	-	-	1	2	2	2	2	1
CO3	3	3	3	3	2	2	-	-	-	-	2	2	2	2	2	2
CO4	3	3	3	3	2	2	-	-	-	-	2	2	2	2	2	2
CO5	3	3	3	3	2	2	-	-	-	-	2	2	2	2	2	2

EC4512	**BASICS OF AVIONICS SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

● To introduce the components and their representation of avionics systems

● To learn various methods for analyzing the System Engineering as a process, System Architecture and integration, Maintainability and reliability.

● To learn the various approach on deploying these skills effectively in the design process of systems in an aircraft.

UNIT I	**BASICS ON AVIONICS**	**9**
Role of Avionics with its Importance – Air Data Systems For Various Needs : Air Data Information and its Use, Air Data Laws and Relationships, Air Data Sensors and Computations , the Avionic Technologies and its Design .		CO1
UNIT II	**DIGITAL AVIONICS SYSTEMS AND ARCHITECTURE**	**9**
Digital number system- number systems and codes, Fundamentals of logic and combinational logic circuits- Avionics Bus architecture - Data buses MIL–RS 232- RS422-RS 485-AFDX/ARINC-664-MIL STD 1553 B–ARINC 429–ARINC 629- Aircraft system Interface		CO2
UNIT III	**INERTIAL SENSORS AND SYSTEMS**	**9**
Laser and MEMS Gyros, Accelerometers, Attitude Heading Reference System – Navigation Systems: Basic Principles, Inertial Navigation, Strapped-Down Inertial Systems – Introduction to Autopilot and UAV Avionics.		CO3
UNIT IV	**TESTING OF AIRCRAFT PERFORMANCE**	**9**
Communications and Criticism on Stake holders - Configuration Control Process-Portrayal of a System- Varying Systems Configurations- Compatibility-Factors Affecting Compatibility –Systems Evolution. Considerations and Integration of Aircraft Systems.		CO4
UNIT V	**SYSTEMS RELIABILITY AND SIMPLE MANOEUVRES**	**9**
Systems and Components-Analysis-Influence, Economics, Design for Reliability-Fault and Failure Analysis-Case Study-Maintenance Types-Program-Planning and Design-– Case Studies Illustrating Importance of Embedded Systems in Avionics — Utility of Radio Navigation Aids(RNA).		CO5
	Total Hours:	**45**
	TEXTBOOKS	

1.	Introduction to Avionics Systems by R.P.G. Collinson, PHI, 5th Edition, 2012.
2.	The Principles of Integrated Technology in Avionics Systems by Guoqing Wang. Tata McGraw Hill, 4th Edition, 2012.
	REFERENCE BOOKS
1.	R. P. G Collinson, "Introduction to Avionics", Springer, 2002.
2.	Kaytonand Fried, "Avionics Navigation Systems", Wiley, 1997.
3.	Frank Vahid, Tony Givargis, "Embedded System Design", Wiley, 2006
4.	Aircraft Systems Mechanical, electrical, and avionics subsystems integration by Ian Moirand Allan Seabridge John Wiley & Sons Ltd (2009)
5.	Introduction to Systems Engineering by Andrew P.Sage and James E.Armstrong. CBS Publishers and Distributors Private Limited, 5th Edition, 2019
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Compute the concepts of System Engineering to the engineers.
CO2	Analysis of avionic systems and to optimize the design.
CO3	Illustrate on various topics such as the System Engineering as a process, System Architecture and integration, Maintainability and reliability.
CO4	Analysis on deploying these skills effectively in the design process of systems in an aircraft.
CO5	Compute the transfer function of different physical systems.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	3	2	2	2	-	-	-	-	2	3	3	2	2	1
CO2	3	3	3	3	2	2	-	-	-	-	2	2	3	2	2	1
CO3	3	2	3	3	2	2	-	-	-	-	2	3	3	2	2	1
CO4	3	3	3	2	2	2	-	-	-	-	2	2	3	2	2	1
CO5	2	2	3	3	2	2	-	-	-	-	2	3	3	2	2	1

EC4513	**POSITIONING AND NAVIGATIONAL SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Understanding of Global Positioning System
- To study the different standard formats of GPS
- Applications of Global positioning Systems
- To study the Global navigation System receiver architectures
- To analyze the Space Weather and GNSS

UNIT I	**INTRODUCTION TO GPS**	**9**
GPS Segments-GPS Satellite Generations-Current GPS Satellite Constellation-Control sites-GPS the basic idea-GPS Positioning service-GPS Signal structure-GPS Modernization-Types of GPS receivers-Time Systems-Pseudo range measurements-Carrier Phase measurements-Cycle		

slips-Linear combination of observables-GPS ephemeris errors-Selective availability-Satellite and receiver clock errors.		
UNIT II	**GPS POSITIONING MODES AND GPS INTEGRATION**	**9**
GPS point and relative positioning-Static GPS surveying-Stop and go GPS surveying-RTK GPS-Real-time differential GPS-Communication Link-DGPS radio beacon systems-Multisite RTK system-RINEX format-NGS-SP3 format-RTCM SC-104 standards for DGPS services-NMEA 0183 format-GPS/GIS Integration-GPS/LRF Integration-GPS/Dead reckoning integration-GPS/INS integration-GPS/Pseudolite integration-GPS/Cellular integration.		
UNIT III	**GPS APPLICATIONS**	**9**
GPS for forestry and natural resources-Precision farming-Civil Engineering applications-Monitoring structural deformations-Open pit mining-Land seismic surveying-Marine Seismic surveying-Airborne mapping-Seafloor mapping-Vehicle Navigation-Retail Industry-Cadastral surveying-GPS stakeout(waypoint navigation)-GLONASS Satellite System.		
UNIT IV	**GNSS RECEIVERS**	**9**
Receiver architecture: Technology, radio-frequency front end, signal processing system hardware and software techniques, software defined radio; **Signal tracking**: Maximum likelihood estimate of delay and position, delay lock tracking of signal, coherent and non-coherent delay lock tracking of pseudo noise sequences, mean square error estimation, vector delay lock loop, receiver noise performance, maximum likelihood estimate, early late gating; **Navigation algorithm**: Measurement of pseudo range, Doppler, decoding and using of navigation data, single point solution, precise point positioning, dynamics of user, Kalman filter, least-squares adjustment, and other alternatives.		
UNIT V	**SPACE WEATHER AND GNSS**	**9**
Sources of space weather and related background physics: Sun, galactic cosmic rays, magnetosphere, thermosphere, ionosphere coupling; Impact of space weather events on GNSS; Satellites, interference with solar radio emission, radio wave propagation; Different view in precise (geodesy, DGPS) and safety of life (aviation) applications; Ionospheric scintillations and their impact, monitoring and modeling; GNSS-based monitoring of the ionosphere by ground and space based measurements; Ionospheric correction and threat models.		
	Total Hours:	45
	TEXTBOOKS	
1.	Introduction to GPS: the Global Positioning System by Ahmed El-Rabbany, Art-tech House 2002	
2.	Understanding GPS Principles and Applications, Elliott D. Kaplan, Christopher J. Hegarty,2nd Edition,2006	
	REFERENCE BOOKS	
1.	Global Navigation Satellite Systems by Office For Outer Space Affairs United Nations office at Vienna United Nations,2012	
2.	Fundamentals of Global Positioning System Receivers: A Software Approach, James Bao-Yen Tsui, John Wiley & Sons, Inc.,2000	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Understand the basic concept of Global Positioning System(GPS)	
CO2	Understand the various modes and formats of GPS	
CO3	Apply various applications of GPS in real time life	
CO4	Apply the technical concepts in developing various architectures and algorithms for signal tracking	
CO5	To design the weather base stations for their local regions	

COs	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	-	-	-	-	-	2	2	2	2	2
CO2	3	2	2	2	2	1	-	-	-	-	-	2	2	2	2	2
CO3	3	3	3	2	2	2	-	-	-	-	-	3	3	2	3	3
CO4	3	3	3	2	2	2	-	-	-	-	-	2	3	2	3	2
CO5	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	3

EC4514	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the basics of satellite orbits
- Understand the satellite subsystems
- Analyze the satellite link design
- Understand the various methods of satellite access
- Explore on the satellite applications

UNIT I	COMMUNICATION SATELLITE: ORBIT AND DESCRIPTION	9

A Brief history of satellite Communication, satellite Frequency Bands, Kepler's Laws, Newton's Law, Terms for Earth-Orbiting Satellites – Orbital Elements - Orbital Perturbations - Station Keeping – Sun-Synchronous Orbit - Geo Stationary and Non Geo-Stationary Orbits – Look Angle Determination - Limits of Visibility – Eclipse - Sub Satellite Point – Sun Transit Outage - Multistage rocket launchers.

UNIT II	SPACE SEGMENT AND EARTH SEGMENT	9

Structure, Primary Power and Attitude and Orbit Control system of Spacecraft Technology, Thermal Control and Propulsion, Communication Payload and supporting subsystems, TT&C subsystem, Transponders, Wideband Receiver, The input demultiplexer, The power Amplifier, Satellite Antenna Equipment.

UNITIII	SATELLITE UPLINK AND DOWNLINK ANALYSIS AND DESIGN	9

Introduction, Equivalent Isotropic Radiated Power, Transmission Losses, The Link-Power Budget Equation, System Noise- Carrier-to-Noise Ratio – The uplink – Saturation Flux density – input Backoff- The earth Station HPA – Downlink – Output Back off – Satellite TWTA Output – Effects of Rain – Combined uplink and downlink C/N Ratio – The downlink - Inter modulation Noise

UNIT IV	SATELLITE ACCESS & CODING TECHNIQUES	9

Single Access – Pre Assigned , Demand Assigned and Random Access Multiple Access - Time Division Multiple Access - Reference Burst, Preamble and Postamble, Carrier Recovery, Network Synchronization, Frame Efficiency and Channel Capacity, Preassigned TDMA, Demand-Assigned

TDMA - Frequency division Multiple Access - Preassigned FDMA, Demand-Assigned FDMA - Code Division Multiple Access - Direct-sequence spread spectrum, Acquisition and tracking, CDMA throughput- Digital video Broadcast, compression – encryption - Symmetric Key Encryption and Asymmetric Key Encryption, Coding Schemes.		
UNIT V	**SATELLITE APPLICATIONS**	**9**
International Telecommunications Satellite Series, Indian National Satellite, A very small aperture terminal, Mobile Satellite Services: The Global System for Mobile Communications, The Global Positioning System, The International Mobile Satellite Organization, Satellite Navigational System. The Global Positioning System - Position Location Principles - Direct To Home - **Oceansat-3**		
	Total Hours:	45
	TEXTBOOKS	
1.	Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2006.	
2.	Timothy,Pratt,Charles,W.Bostain,JeremyE.Allnutt,"SatelliteCommunication",2ndEdition, Wiley Publications,2002	
	REFERENCE BOOKS	
1.	Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007.	
2.	N.Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Analyze the satellite orbits.	
CO2	Analyze the satellite subsystems.	
CO3	Analyze the satellite Link design.	
CO4	Describe about Multiple Access Techniques used in Satellite.	
CO5	Design various satellite applications.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	1	3	1	1	1	-	-	1	3	3	1	1
CO2	3	3	3	3	1	3	1	1	-	-	-	1	3	3	2	1
CO3	3	3	3	3	1	3	1	1	1	1	-	2	3	3	2	2
CO4	3	3	3	3	2	3	1	1	-	1	-	3	3	3	2	1
CO5	3	3	3	3	2	3	2	1	1	1	1	3	3	3	2	2

EC4515	**REMOTE SENSING TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the application potentialities of remote sensing data separately and in combination with GIS techniques for Agriculture and Forestry.
- To know the concept of Geographical Information System (GIS), coordinate system GIS Data and its types.
- To understand the students managing the spatial Data Using GIS.
- To understand Implementation of GIS interface for practical usage.
- Elucidate integrated geospatial techniques and apply them in solving real world problems

UNIT I	**CROPS ACREAGE AND YIELD ESTIMATION**	**9**
Introduction – Spectral properties of crops in optical & TIR region, Microwave back scattering behavior of crop canopy – crops identification and crop inventory – crop acreage estimation – vegetation indices – Yield modeling – crop production forecasting through digital analysis – crop condition assessment – command area monitoring – land use and land cover analysis – Microwave RS for crop inventory – Case studies.		CO1
UNIT II	**ENVIRONMENTAL SCIENCE**	**9**
Natural disasters – introduction and types-Disaster management cycle and role of remote sensing and GIS in disasters management -Remote sensing and GIS application in hazard zonation mapping-Remote sensing and GIS application in post disasters		CO2
UNIT III	**AERIAL ASSESSMENT**	**9**
Mapping of snow covered area – snow melt runoff – flood forecasting, risk mapping and flood damage assessment soil moisture area – drought forecasting and damage assessment – GIS application in aerial assessment – case studies		CO3
UNIT IV	**FORESTRY**	**9**
Introduction – Forest taxonomy – inventory of forestlands – forest types and density mapping using RS techniques – Forest stock mapping – factors for degradation of forest – Delineation of degraded forest- Forest change detection and monitoring – Forest fire mapping & damage assessment – LiDAR remote sensing for Forest studies.		CO4
UNIT V	**INTEGRATED SURVEYS**	**9**
Introduction – Integrated surveys for agriculture & forest development – RS & GIS for drawing out action plans – water shed approach – Rule of RS & GIS for watershed management – Land use planning for sustainable development – Precision forming - Case studies.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Jensen,J.R. 2000: Remote Sensing of the Environment: An Earth resource Perspective. Prentice Hall
2.	Dr. David Maidment, Dr. Dean Djokic, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems, Esri Press 2000

	REFERENCE BOOKS

1.	John G. Lyon, Jack MCcarthy, Wetland & Environmental application of GIS,1995.
2.	Margareb Kalacska, G. Arturosanchez, Hyper spectral RS of tropical and sub- tropical forest, 2005.
3.	Shunlin liang , Advances in land RS: System, modeling invention and applications, 2001.
4.	Joe Boris dexon, Soil mineralogy with environmental application, Library of congress catalog, 2004

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the concepts involved in mapping of crop acreage and yield estimation.
CO2	Understand the principles space-based input for crop damage assessment.
CO3	Acquire skills in handling instruments, tools, techniques and modeling while using Remote Sensing Technology.
CO4	Gain knowledge about mapping and assessment of forestry
CO5	Gain skills in various applications of Forestry and sustainable watershed management.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	1	1	2	2	2	-	-	-	-	2	3	2	-	2
CO2	2	2	2	2	1	2	2	-	-	-	-	2	3	2	-	2
CO3	2	1	2	2	2	3	2	-	-	-	-	2	3	2	-	2
CO4	2	2	2	2	1	2	2	-	-	-	-	2	3	2	-	2
CO5	2	2	3	2	2	3	2	-	-	-	-	2	3	2	-	2

EC4516	**ROCKETRY AND SPACE MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

Upon completion of the course, students will have

- an idea about solar system,
- basic concepts of orbital mechanics with particular emphasis on interplanetary trajectories.

UNIT I	**ORBITAL MECHANICS**	**9**
Kepler's Laws – Newton's Law of gravitation-Solar system Description – Problems on Two body and Three-body Points on Liberation – Orbital and escape velocities- Orbit parameters calculations.		CO1
UNIT II	**SATELLITE DYNAMICS AND LAWS**	**9**
Geostationary and Geosynchronous satellites- satellites life time– satellite perturbations and calculations- Hohmann orbits – Jacobi's Integral – orbital elements for rectangular satellite coordinates.		CO2
UNIT III	**ROCKET MOTION**	**9**

Rocket motor operation – free space and homogeneous gravitational fields in one dimensional and two dimensional rocket motions - thrust equation- turn trajectories in vertical, inclined and gravity, Range and altitude determinations.		CO3
UNIT IV	**AERODYNAMICS IN ROCKET PROJECTION**	**9**
Loads experienced by a rocket passing through atmosphere – estimation of drag – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – various altitudes performance – Adapted nozzles - nozzles types bell and conical shaped – rocket dispersion – launching problems.		CO4
UNIT V	**CONTROL OF ROCKET VEHICLES AND STAGING**	**9**
Multi-staging of rocket vehicles needs– optimizing multistage vehicles – techniques for stage separation dynamics and separation stages - jet control methods of rocket vehicles and aerodynamics- PSLV Secondary Injection Thrust Vector Control system and RSC tanks.		CO5
	Total Hours:	45

	TEXTBOOKS
1.	Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co.,Ltd, London, 1982
2.	Parker, E.R., "Materials for Missiles and Spacecraft", Mc.Graw Hill Book Co. Inc., 1982.
	REFERENCE BOOKS
1.	G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
2.	Van de Kamp, "Elements of astromechanics", Pitman Publishing Co., Ltd., London, 1980.
3.	Heiser, W. H. and Pratt, D. T., "Hypersonic Air Breathing Propulsion", AIAA, 1994.
4.	Hill P. G., and Peterson C. R., "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Ed., 2009.
5.	Oates G. C., "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the advanced concepts in Rocketry and Space Mechanics to the engineers and
CO2	To provide the necessary mathematical knowledge that is needed in understanding the physical processes.
CO3	The students will have an exposure on various topics such as Orbital Mechanics, Rocket Propulsion and Aerodynamics
CO4	Understand the Rocket Staging and will be able to deploy these skills effectively
CO5	Understanding of Rockets and like spacecraft systems.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PS O3**	**PSO 4**
CO1	3	3	3	1	2	1	-	-	-	-	-	1	1	1	1	1
CO2	3	3	3	1	2	1	-	-	-	-	-	1	1	1	1	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	1
CO4	3	3	3	3	2	3	-	-	-	-	-	3	3	3	3	1

CO5	3	3	2	3	2	3	-	-	-	-	-	3	3	3	3	1

VERTICAL II

EC4521	**WIDE BANDGAP DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Provide an introduction to basic operation of Si and wide band gap power devices.
- To master design principles of power devices.
- To compete with specifications of commercial power devices.
- To expose the processing details of power devices.
- To become familiar with reliability issues and testing methods.

UNIT I	**INTRODUCTION**	**9**
Introduction: Basic power devices- its characteristics and applications - Material Properties of Silicon and other wide band gap semiconductors - Design for Breakdown Voltage various edge terminations- Ideal Specification on-Resistance for Silicon and Wide Band Gap devices - Forward conduction and reverse blocking of Schottky Diodes and Schottky Diodes commercial specifications – Design of PIN Diodes, its Forward conduction and reverse blocking and commercial specifications of PIN Diodes.		CO1
UNIT II	**WBG -MOSFET AND HFET**	**9**
Planar power MOSFETs- Operation: Forward conduction and forward blocking - Channel mobility - Design of planar power MOSFETs using Si and SiC - Dynamic operation - Unclamped inductive switching and short circuit time - Latch up and Safe Operating Area (SOA) - Commercial specifications and applications of Si and SiC planar power MOSFETs - GaN and Ultra WBG Lateral Power HFETs - Si and SiC IGBTs - Its Structure and Operation - Asymmetric and Symmetric designs - Forward conduction and Forward blocking of HFETs		CO2
UNIT III	**MATERIAL PROPERTIES AND DESIGN OF SiC**	**9**
Crystal and Band structures – Electrical Properties of SiC – Physical Properties of SiC – Defects and Carrier lifetimes – SiC Diode – PiN Diode -Bipolar Degradation – SiC MOSFET: Fabrication process, device structure - SiC IGBT: Fabrication process, device structure		CO3
UNIT IV	**PHYSICAL PROPERTIES OF GaN**	**9**
Crystal structure and properties of GaN – Polarozation Charges – Band structure and corresponding properties of GaN – Impact Ionization Coefficients – Defects in GaN – Design and device structure of GaN – its performance, commercial examples – Monolithic Integration		CO4
UNIT V	**APPLICATIONS OF SiC AND GaN DEVICES**	**9**
Bidirectional buck/boost converter – High frequency PFC with PCB winding Couple inductor – 400V/12V DCX server applications – EMI filter for high frequency GaN converters – SiC device Retrospective – applications with SiC devices		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Baliga, B. Jayant, Gallium nitride and silicon carbide power devices. world scientific publishing company, 2016.
2	Baliga, B. Jayant, ed, Wide Bandgap Semiconductor Power Devices: Materials, Physics, Design, and Applications. Woodhead Publishing, 2018.
	REFERENCE BOOKS
1	Baliga, B. Jayant, The IGBT device: physics, design and applications of the insulated gate bipolar transistor. William Andrew, 2015.
2	Baliga, B. Jayant, Fundamentals of power semiconductor devices. Springer Science & Business

3	Katsuaki Suganuma. Wide Bandgap Power Semiconductor Packaging: Materials, Components and Reliability. Woodhead Publishing, 2018.
4	Kiyoshi Takahashi, Akihiko Yoshikawa, Adarsh Sandhu, Wide Bandgap Semiconductors, Fundamental Properties and Modern Photonic and Electronic Devices Springer, 2007.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Learn basic operation of Si and wide band gap power devices.
CO2	Analyze and apply design principles of power devices.
CO3	Compete with specifications of commercial power devices.
CO4	Expose the processing details of power devices.
CO5	Recognize reliability issues and testing methods.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
	PROGRAMME OUTCOMES												**PROGRAMME SPECIFICOUTCOMES**			
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	3	1	2	-	-	-	-	2	3	3	3	3	2
CO2	3	2	3	3	1	2	-	-	-	-	2	3	3	3	3	2
CO3	3	3	3	3	2	2	-	-	-	-	2	3	3	3	3	2
CO4	3	3	3	3	3	2	-	-	-	-	2	3	3	3	3	2
CO5	3	3	3	3	3	2	-	-	-	-	2	3	3	3	3	2

EC4522	**RFID SYSTEM DESIGN & TESTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the basics of radio frequency identification systems
- Be familiar with Radio frequency system design and standards.
- Ability to understand the details of matching network, amplifiers, oscillators, mixer and noise.

UNIT I	**BASICS OF RADIO FREQUENCY IDENTIFICATION (RFID) SYSTEMS**	**9**
RFID basics, Principle and Technology - Automatic Identification Systems - Automatic Identification and Data Capture (AIDC), System Components of an RFID system: labels, Tag, Reader, Architecture: RF Subsystem- Enterprise Subsystem- Inter-Enterprise Subsystem, RFID issues. RFID Applications.		CO1
UNITII	**RFID SYSTEM STANDARDS AND TESTING**	**9**
Operating Frequency Ranges, Limiting factors for RFID, Effects and advantages, Communication protocols, collision problem and types of solution, Tag collision and various several protocol approaches, RFID Technology - Middleware architecture; EPC standards, RFID deployment challenges, RFID services value chain		CO2
UNIT III	**IMPEDANCE MATCHING AND AMPLIFIERS**	**9**
Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match , Single ended and Differential schemes		CO3
UNIT IV	**FEEDBACK SYSTEMS AND POWER AMPLIFIERS**	**9**

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, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations		CO4
UNIT V	**RF FILTER , OSILLATOR, MIXER**	**9**
Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phases locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	Thomas Lee," The Design of Radio Frequency CMOS Integrated Circuits", Cambridge University Press, 2nd Edition, Cambridge, 2004.	
2.	Steven Shepard, "RFID: Radio frequency and Identification", Tata McGraw – Hill, 2010	
	REFERENCE BOOKS	
1.	Matthew M.Radmanesh," Radio frequency and Microwave Electronics illustrated", Pearson Education Inc, Delhi, 2006.	
2.	B.Razavi, "RF Microelectronics", Pearson Education, 1997.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Demonstrate the concepts of RFID systems, and components of the RFID system	
CO2	Analyze the different RFID technology and standards	
CO3	Understand the concepts of impedance matching and amplifiers	
CO4	Ability to learn about the feedback systems and power amplifiers	
CO5	Understand the functions of mixers and oscillators	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFICOUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	3	3	-	-	-	-	-	2	3	3	3	1
CO2	3	3	3	2	3	3	-	-	-	-	-	2	3	3	3	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	3	3	1	1
CO4	3	3	3	2	3	2	-	-	-	-	-	2	3	2	1	1
CO5	3	3	2	1	2	2	-	-	-	-	-	2	3	2	2	1

EC4523	**ANTENNA DESIGN TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand Antenna basics
- To learn about Antenna arrays and their characteristics
- To study about Radiation Mechanism
- To familiarize with Microstrip Antennas and design techniques
- To learn about recent trends in Antenna design

UNIT I	**FUNDAMENTAL PARAMETERS OF ANTENNAS**	**9**
Introduction to Antenna - Physical Concept of Radiation, Antenna Pattern Characteristics, near- and far-field regions, Radiation Power Density, Radiation Intensity, Radiation Efficiency, Antenna Gain, Directivity and Efficiency, Aperture Efficiency and Effective Area, Bandwidth and input impedance, Impedance matching, Radiation resistance, Antenna Noise Temperature and G/T, Friis transmission equation, Link budget and link margin.		CO1
UNIT II	**ANTENNA TYPES AND DESIGN CONSIDERATIONS**	**9**
Radiation Mechanisms and Design Considerations of Wire antennas: Dipole, Loop, travelling wave antennas –Aperture Antennas: Radiation from horn antennas, design concepts, Reflector Antennas – Broadband Antennas: Spiral, Helical and log periodic antenna, and its applications.		CO2
UNIT III	**ANTENNA ARRAYS AND SMART ANTENNAS**	**9**
Two-Element Array, Array Factor, Pattern Multiplication, Broadside-End Fire Array, Phased Array and Binomial Array, Concept and Benefits of Smart Antennas, Fixed Weight Beamforming, Adaptive Beamforming – Beam Steering.		CO3
UNIT IV	**MICROSTRIP PATCH ANTENNA**	**9**
Microstrip Antennas – Introduction, Features, Advantages and Limitations– Characteristics of microstrip antennas – Design and analysis of rectangular patch, Circular patch– Microstrip array and feed network, Radiation mechanism of slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas.		CO4
UNIT V	**MODERN ANTENNA DESIGN**	**9**
Antennas for Millimeter Wave Communication – MIMO Antenna, Diversity Techniques – Introduction to Metamaterials – Types and Design of Metamaterial Antennas – Biomedical Antennas – Plasma Antennas, Case studies : Massive MIMO antennas		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, Fourth Edition, 2012.	
2.	Kraus. J.D, "Antennas", John Wiley and sons, New York, Second edition, 1997.	
3.	Frank B. Gross, "Frontiers in Antennas", Mc Graw Hill, 2011.	
4.	S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Springer Publications, 2nd Edition, 2007.	
	REFERENCE BOOKS	
1.	I.J. Bahl and P. Bhartia, "Microstrip Antennas",Artech House,Inc.,1980	
2.	W.L.Stutzman and G.A.Thiele, "Antenna Theory and Design", John Wiley & Sons Inc., second edition, 1998.	
3.	S.Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, "Modern Antennas", Springer Publications, 2nd Edition, 2007.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Understand the fundamentals behind the different techniques in antenna technology.	
CO2	Understand the different types of antennas and its design consideration.	
CO3	Understand the challenges associated in designing antennas based on different technologies	
CO4	Design and analyze micro strip antennas for a given specifications.	
CO5	Understand the need for optimizing in antenna design and the methodologies	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3

COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	2	3	3	3	3	2	1	3	2	3	2	2	3
CO2	3	2	2	3	-	2	1	2	2	3	2	2	3	1	2	3
CO3	3	3	2	2	3	-	3	1	2	-	1	2	3	3	2	2
CO4	3	2	1	2	2	1	3	2	1	3	2	1	2	2	1	3
CO5	2	2	3	2	2	3	3	1	-	-	1	2	1	2	2	2

EC4524	VLSI TESTING AND DESIGN FOR TESTABILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide or broad understanding of fault diagnosis.
- To illustrate the framework of test pattern generation.
- To understand design for testability in Digital Design

UNIT I	**FAULTS IN CIRCUITS AND PROBLEMS IN TESTING**	**9**
Testing -Need for testing a circuit, the problems in digital and Analog Design testing/ mixed design testing, design for test, PCB testing, software testing Fault in Digital Circuits: Controllability and Observability, Fault Models, intermittent faults.		
UNIT II	**TEST PATTERNS AND ALGORITHMS**	**9**
Test pattern generation introduction, Test Pattern generation for combinational logic circuits - Manual and automatic, Boolean difference method, Roth's D- algorithm, Developments following Roth's D-algorithm, Pseudo random test pattern generation.		
UNIT III	**VLSI IC TESTING**	**9**
Pseudo random test pattern generators, Linear feedback shift registers (LFSRs) - Test pattern generator design and cellular automata(Cas)		
UNIT IV	**TECHNIQUES FOR COMBINATIONAL CIRCUITS TESTING**	**9**
Design for Testability -Basic Concepts, controllability and observability, the Reed Muller's expansion techniques, control logic and syndrome testable designs for testing.		
UNIT V	**SCAN ARCHITECTURES**	**9**
Sequential circuits testing - testability insertion, full scan DFT technique, scan architectures		
	Total Hours:	45

	TEXTBOOKS
1.	Fault Tolerant and Fault Testable Hardware Design-Parag K. Lala, 1984, PHI.
2.	VLSI Testing digital and Mixed analogue/digital techniques-Stanley L. Hurst, IEE Circuits, Devices and Systems series 9, 1998
	REFERENCE BOOKS
1.	Digital Systems Testing and Testable Design-Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Jai co Books
2.	Essentials of Electronic Testing-Bushnell and Vishwani D.Agarwal, Springers.
3.	Design for test for Digital IC's and Embedded Core Systems-Alfred L. Crouch, 2008, Pearson Education.
	COURSE OUTCOMES:
CO1	Acquire the knowledge of fundamental concepts in fault and fault diagnosis
CO2	Acquire knowledge about testing methods
CO3	Test pattern generation using LFSR and CA
CO4	Design for testability rules and techniques for combinational circuits
CO5	Introducing scan architectures

MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVELS 1/2/3																
	PROGRAMME OUTCOMES												PROGRAMME SPECIFICOUTCOMES			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	1	-	-	-	-	2	2	3	3	2	0
CO2	3	3	3	2	2	1	-	-	-	-	2	2	3	3	2	0
CO3	2	3	3	2	2	1	-	-	-	-	2	2	3	3	2	0
CO4	3	2	2	2	2	1	-	-	-	-	2	2	3	3	2	0
CO5	3	2	2	2	2	1	-	-	-	-	2	2	3	3	2	0

EC4525	**FPGA BASED EMBEDDED DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Understand Digital system design using HDL.
- Know FPGA architecture, interconnect and technologies.
- Know different FPGA's and implementation methodologies.
- Understand configuring and implementing digital embedded system, microcontrollers, microprocessors, DSP algorithm on FPGA.

UNIT I	**HARDWARE DESCRIPTION LANGUAGE**	**9**
Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions.		CO1
UNIT II	**FPGA ARCHITECTURE**	**9**
FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad.		CO2
UNIT III	**MODELLING OF CIRCUITS**	**9**
Verilog Modelling of Combinational and Sequential Circuits: Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.		CO3
UNIT IV	**SEQUENTIAL CIRCUIT**	**9**
Synchronous Sequential Circuit: State diagram-state table –state assignment-choice of flipflops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection- Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller.		CO4
UNIT V	**CASE STUDIES**	**9**
System Design Examples using Xilinx FPGAs – Traffic light Controller, Real Time Clock - Interfacing using FPGA: VGA, Keyboard, LCD, Embedded Processor Hardware Design.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	M.J.S. Smith, "Application Specific Integrated Circuits", Pearson, 2000.
2.	Peter Ashenden, "Digital Design using VHDL", Elsevier, 2007.
3.	Clive Maxfield, "The Design Warriors's Guide to FPGAs", Elsevier, 2004
	REFERENCE BOOKS
1.	Peter Ashenden, "Digital Design using Verilog", Elsevier, 2007. 4. W. Wolf, "FPGA based system design", Pearson, 2004.
2.	S. Ramachandran, "Digital VLSI System Design: A Design Manual for implementation of

	Projects on FPGAs and ASICs Using Verilog" Springer Publication, 2007
3.	Wayne Wolf, "FPGA Based System Design", Prentices Hall Modern Semiconductor Design
4.	Stephen Brown &ZvonkoVranesic, "Digital Logic Design with Verilog HDL" TATA McGraw Hill Ltd. 2nd Edition 2007
5.	T.R. Padmanabhan, B.Bala Tripura Sundari, "Design through Verilog HDL" Wiley Interscience, 2004.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the various HDL Programming styles
CO2	Understand the FPGA Architecture
CO3	Design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels
CO4	Design and optimize complex combinational and sequential digital circuits
CO5	Implementation of digital circuits in FPGA

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	2	1	2	-	-	-	-	2	2	3	2	1	1
CO2	3	3	3	2	1	2	-	-	-	-	2	2	3	2	1	1
CO3	3	3	3	2	1	2	-	-	-	-	2	2	3	2	2	1
CO4	3	3	3	2	1	2	-	-	-	-	2	2	3	2	3	1
CO5	3	3	3	2	1	2	-	-	-	-	2	2	3	2	3	1

EC4526	**DESIGN OF ANALOG IC**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To study the fundamentals of analog circuits and MOS device models
- To gain knowledge on various configurations of MOS transistors and feedback concepts
- To study the characteristics of noise and frequency response of the amplifier
- To learn the concepts of Op-Amp, Nonlinear analog circuits and PLLs

UNIT I	**INTRODUCTION TO ANALOG IC DESIGN AND CURRENT MIRRORS**	**9**
Concepts of Analog Design - General consideration of MOS devices – MOS I/V Characteristics – Second order effects – MOS device models. Basic current mirrors- Cascode current mirrors - Active current mirrors- Large and Small signal analysis- Common mode properties.		CO1
UNITII	**AMPLIFIERS AND FEEDBACK**	**9**
Basic Concepts – Common source stage- Source follower- Common gate stage- Cascode stage. Single ended and differential operation- Basic Differential pair- Common mode response, Differential pair with MOS loads. Feedback- General Considerations of feedback circuits- Feedback topologies- Effect of loading- Effect of feedback on Noise.		CO2
UNIT III	**FREQUENCY RESPONSE OF AMPLIFIERS AND OPERATIONAL AMPLIFIER**	**9**

General considerations- Miller Effect and Association of Poles with Nodes, Common source stage, Source followers, Common gate stage, Cascode stage, Differential pair. Op Amp General Considerations- One and Two Stage Op Amps- Gain Boosting- Comparison- Common mode feedback- Input range limitations- Slew rate.		CO3
UNIT IV	**NONLINEAR ANALOG CIRCUITS**	**9**
Precision rectification – Analog multipliers employing the Bipolar transistor-The emitter coupled Pair as a simple multiplier- The dc analysis of the Gilbert Multiplier cell- The Gilbert cell as an analog multiplier cell. Phase Locked Loop (PLL) concepts- Integrated circuits PLL.		CO4
UNIT V	**NOISE IN INTEGRATED CIRCUITS**	**9**
Sources of Noise- Shot, Thermal, Flicker, Burst & Avalanche. Noise Models of IC components- Junction Diode-Bipolar Transistor-MOS Transistor-Resistors-Capacitor & Inductors-Noise in Operational Amplifiers.		CO5
	Total Hours:	45

	TEXTBOOKS
1.	Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2001, 33rd re-print, 2016. (UNIT- I, II, III,V)
2.	Gray,Hurst,Lewis,Meyer "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons,Inc, Fourth Edition. (UNIT- IV, V)
	REFERENCE BOOKS
1.	Phillip Allen and Douglas Holmberg "CMOS Analog Circuit Design" Second Edition, Oxford University Press, 2004
2.	Grebene, "Bipolar and MOS Analog Integrated circuit design", John Wiley & sons, Inc., 2003
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Realize the concepts of Analog MOS devices and current mirror circuits.
CO2	Design different configuration of Amplifiers and feedback circuits.
CO3	Analyze the characteristics of frequency response of the amplifier and OpAmp Circuits.
CO4	Analyze the performance of analog multipliers and PLLs.
CO5	Acquire knowledge about sources of noises, noise models.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	1	-	-	-	-	-	2	3	2	1	1
CO2	3	3	2	2	2	1	-	-	-	-	-	2	3	2	1	1
CO3	3	3	2	2	2	1	-	-	-	-	-	2	3	2	1	1
CO4	3	3	2	2	2	1	-	-	-	-	-	2	3	2	1	1
CO5	3	3	2	2	2	1	-	-	-	-	-	2	2	1	1	1

VERTICAL – III

EC4531	**WEARABLE DEVICES**	**L**	**T**	**P**	**C**

	3	**0**	**0**	**3**

OBJECTIVES:

- Describe and discuss constraints unique to wearable and ubiquitous computing platforms and applications
- Design, develop and evaluate a wearable devices and its application,
- Apply state-of-the-art hardware and software development tools to computer system design, and
- Communicate both orally and in writing with other members of a team

UNIT I	**INTRODUCTION**	**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.		CO1
UNIT II	**APPLICATIONS OF WEARABLE DEVICES**	**9**
Smart connectivity and Big picture of IoT-smart devices, networks, Wireless technologies and need for data analysis. Evolution of wearable technology, Wearable IoT use cases- Smart watches , Android wear, Smart glasses, fitness trackers, health care devices, cameras, smart clothing. Case studies – Health care, fitness and sports, defence and security, fashion and apparel.		CO2
UNIT III	**WEARABLE SENSORS**	**9**
Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility		CO3
UNIT IV	**SIGNAL PROCESSING**	**9**
Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Datamining.		CO4
UNIT V	**ENERGY HARVESTING FOR WEARABLE DEVICES**	**9**
Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.		CO5
	Total Hours:	45

	TEXTBOOKS
1.	Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer,2011.
2.	Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalized Health Management - State of the art and future challenges ' IOS press, The Netherlands,2004.
	REFERENCE BOOKS
1.	Hang,Yuan-Ting, "Wearable medical sensors andsystems",Springer-2013.
2.	Raj Kamal, “Internet of Things – Architecture and Design Principles”, Mc Graw H ill Education Pvt.Ltd., 2017.

3.	Edward Sazonov, Michael R Neuman, “Wearable Sensors: Fundamentals, Implementation and Applications” Elsevier, 2014
4.	Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore,2012
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Design and perform experiments on the sensors and develop the projects based on the customer needs.
CO2	Understand the role of IoT in wearable devices
CO3	Understand the various wearable sensors and its applications
CO4	Explain the sensor and signal processing requirement of wearable systems
CO5	Elucidate the level of energy involvement in wearable systems

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	2
CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2	2
CO3	3	3	2	2	2	2	-	-	-	-	-	3	3	2	2	2
CO4	3	3	3	3	2	2	-	-	-	-	-	2	3	2	3	2
CO5	3	3	3	3	2	1	-	-	-	-	-	2	3	2	3	2

EC4532	**HUMAN ASSIST DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To gain knowledge of human anatomy
- To acquire knowledge of various cardiac assist devices
- To know the principle and design of Heart lung machine and artificial heart
- To Gain knowledge in visual and hearing aids
- To study implantation of artificial kidney

UNIT I	**INTRODUCTION: HUMAN ANATOMY and PHYSIOLOGY**	**9**
Anatomy and Physiological aspects - Human Heart - Respiration - Human Kidney - Structure of Nephron – Optics of Eye – Retina – Physiology of Internal Ear – Mechanism of Hearing		**CO1**
UNIT II	**ASSIST DEVICES : HEART**	**9**
By-pass pump - open chest and closed chest type - Principle and problems - Intra-Aortic balloon pumping - Venal Arterial Pumping - Prosthetic Cardio Valves - Implantable Biomaterials - Characteristics and testing		CO2

UNITIII	**HEART LUNG MACHINE AND RESPIRATORY AIDS**	**9**
Oxygenators – Types - Pumps - Pulsatile and Continuous Types - Monitoring Process - Need for Cardiac Transplant - Artificial Heart: Types – Function - Breathing Apparatus - Operating Sequence - Intermittent positive pressure - Breathing unit with all respiratory parameters		CO3
UNIT IV	**VISUAL AND HEARING AIDS**	**9**
Ultra sonic and laser canes - Intra ocular lens - Braille Reader - Tactile devices for visually Challenged - Text to voice converter - Screen readers -Types of Deafness - Hearing Aids - Construction and Functional Characteristics		CO4
UNIT V	**ARTIFICIAL KIDNEY**	**9**
Principle of Haemodialysis – Membrane – Dialysate - Different types of hemodialyzers - Monitoring Systems - Wearable Artificial Kidney - Implanting Type		CO5
	Total Hours:	45
	TEXT BOOKS	
1.	Rory A Cooper, An Introduction to Rehabilitation Engineering, Taylor & Francics ,CRC Press,2006	
2.	Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006	
	REFERENCE BOOKS	
1.	Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", Springer Publications, First edition, 2008.	
2.	Kolff W.J., Artificial Organs, John Wiley and Sons, New York, 1979.	
3.	Assistive Technology- Principles & Practice- Cook & Hussey, Mosby; 3rd edition (1 November 2007); CBS Publishers & Distributors Pvt. Ltd.	
4.	Short Textbook of Prosthetics and Orthotics- R Chinnathurai- Jaypee Brothers Medical Publishers (P) Ltd-2010	
5.	Gerr . M. Craddock "Assistive Technology-Shaping the future", IOS Press, 1st edition, 2003.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Knowledge about Human Anatomy	
CO2	Knowledge about the importance of cardiac assist devices	
CO3	Knowledge about the importance of Heart lung machine and artificial Heart	
CO4	Perceive the knowledge in different types of visual and hearing aids	
CO5	Understand about the implantation of artificial kidney	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	1	3	3	3	3	-	-	-	-	2	2	3	2	2	2
CO2	3	1	3	3	3	3	-	-	-	-	2	2	3	2	2	2
CO3	3	1	3	3	3	3	-	-	-	-	2	2	3	2	2	2
CO4	3	1	3	3	3	3	-	-	-	-	2	2	3	3	2	2
CO5	3	1	3	3	3	3	-	-	-	-	2	2	3	3	2	2

EC4533	THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the devices for measurement of parameters related to cardiology.
- Illustrate the recording and measurement of EEG
- Demonstrate EMG recording unit and its uses.
- Understand the Principles and applications of surgical diathermy
- Explain diagnostic and therapeutic devices related to respiratory parameters.

UNIT I	CARDIAC PACEMAKERS & DEFIBRILLATORS	9
Different modes of operation. External, internal, and Programmable pacemakers. Pulse generator: sensing, output and timing circuits. Power sources, electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, Pacer- cardioverter defibrillator – block diagram, defibrillator analysers.		CO1
UNIT II	**NEUROLOGICAL EQUIPMENT & VENTILATORS**	**9**
Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential– Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting. Types of ventilators, Heart lung machine (HLM) – principle of operation-functional block diagram - types of oxygenators. Extracorporeal membrane oxygenation (ECMO) machine		CO2
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.		CO3
UNIT IV	**SURGICAL DIATHERMY & LASER**	**9**
Principles and applications of surgical diathermy, Physics and engineering of ultrasonic lithotripter, basic principle of extracorporeal shock wave lithotripter, Electro-surgical analysers. Principle operation of LASER, various application of CO2, argon, He -Ne, Nd – YAG & pulsed ruby LASER, Application of LASER in surgery		CO4
UNIT V	**RESPIRATORY MEASUREMENT SYSTEM**	**9**
Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer – Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.		CO5
	Total Hours:	45

	TEXTBOOKS
1.	John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India PvtLtd,New Delhi, 2015
2.	Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson education, 2012.
	REFERENCE BOOKS
1.	Mym er Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw Hill, 2003.

2.	L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008
3.	Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007
4.	Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
5.	B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers. 2001.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Describe the working and recording setup of all basic cardiac equipment.
CO2	Understand the working and recording of all basic neurological equipment's.
CO3	Discuss the recording of diagnostic and therapeutic equipment's related to EMG.
CO4	Justify the application of lasers and laser in surgery
CO5	Explain about measurements of parameters related to respiratory system

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**								**PROGRAMME SPECIFIC OUTCOMES**							
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2	2	3	1	2	2	-	-	-	2	2	**2**	**2**	**2**	**2**
CO2	3	2	2	3	1	2	1	-	-	-	2	2	**2**	**2**	**2**	**2**
CO3	3	2	2	3	1	2	1	-	-	-	2	2	**2**	**2**	**2**	**2**
CO4	3	2	2	3	3	2	3	-	-	-	2	2	**2**	**2**	**2**	**2**
CO5	3	2	2	3	3	2	3	-	-	-	2	2	**2**	**3**	**3**	**1**

EC4534	**MEDICAL IMAGING SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To study about the various types of X-ray Imaging
- To understand the characteristics of Fluoroscopy and its Peripheral equipment
- To study the principle of CT imaging and advancement in fMRI
- To learn about microwave and infrared medical imaging modalities.
- To understand the concepts of radioisotope and nuclear imaging

UNIT I	**X-RAY IMAGING**	**9**
Physics of X-rays, X-ray production, detection, hardware/instrumentation of Projection radiography, Digital angiography, Mammography and fluoroscopy.		CO1
UNIT II	**FLUOROSCOPY**	**9**
Fluoroscopic imaging chain components – Characteristics of Image intensifier performance - Modes of operation – Image quality – Radiation dose – Fluoroscopic suites – Peripheral equipment – Optical coupling – Video cameras.		CO2
UNIT III	**MAGNETIC RESONANCE IMAGING(MRI) AND COMPUTED TOMOGRAPHY (CT)**	**9**
Introduction to functional MRI – Basics of MRI Signal, Tissue contrast and spatial localization - Neuronal activity and Hemodynamics – BOLD fMRI – SNR in fMRI – Experimental design - Advanced MRI.Spiral/Helical and multi-slice CT Detectors Image reconstruction.		CO3
UNIT IV	**MICROWAVE AND INFRARED IMAGING**	**9**

Introduction, Electromagnetic scattering – Elecromagnetic inverse scattering problem -Imaging configuration – Model approximations – Qualitative reconstruction methods -Microwave imaging apparatus – Infrared imaging- Thermography – Clinical applications of thermography – liquid crystal thermography.		CO4
UNIT V	**ULTRASOUND IMAGING**	**9**
Wave propagation, acoustic impedance, absorption and attenuation Single element ultrasound transducers and ultrasound field Transducer array Imaging modes , Doppler ultrasound Ultrasound contrast agents Applications.		CO5
	Total Hours:	45
	TEXT BOOKS	
1.	Khandpur R S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.	
2.	William hendee R, Russell Ritenour E, "Medical imaging physics", Fourth Edition, 2002.	
	REFERENCE BOOKS	
1.	Stephan Ulmer, Olav Jansen, "FMRI: Basics and Clinical Applications", springer, first Edition,2010.	
2.	Matteo Pastorin , "Microwave imaging", John Wiley and Sons first edition , 2010.	
3.	Joseph J. Carr and John M.Brown, "Introduction to Biomedical Equipment Technology", Pearson Education,2004.	
	Chan and Anthony Y.K,''Biomedical Device Technology: Principles and Design'', Springfield, Illinois Charles C. Thomas publisher Limited,2016.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	To study about fluoroscopic imaging techniques and components.	
CO2	To learn about the principle, reconstruction ,artifacts with CT imaging	
CO3	To understand the basics and advancement in fMRI	
CO4	To learn about microwave and infrared medical imaging modalities.	
CO5	To understand the concepts of radioisotope and nuclear imaging	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	1	2	-	-	-	-	-	2	1	3	2	1
CO2	3	3	3	2	1	2	-	-	-	-	-	2	2	3	2	2
CO3	3	3	3	2	2	2	-	-	-	-	-	1	2	3	2	2
CO4	3	3	3	2	3	3	-	-	-	-	-	3	2	3	3	2
CO5	3	3	3	2	3	3	-	-	-	-	-	3	2	3	3	1

EC4535	**BRAIN COMPUTER INTERFACE AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Understand the basic concepts of brain computer interface
- Study the various signal acquisition methods
- Learn about the signal processing methods used in BCI
- Understand the various machine learning methods of BCI.
- Learn the various applications of BCI

UNIT I	**INTRODUCTION TO BCI**	**9**
Introduction - Structure of BCI System, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, , BCI Monitoring Hardware, Brain signal acquisition -EEG, ECoG, MEG, fMRI, Signal Preprocessing, Artifacts removal		CO1
UNITII	**BRAIN ACTIVATION**	**9**
Brain activation patterns - Spikes,ERD, Sensorimotor activity, Oscillatory potential, slow cortical potentials, Movement related potentials-Mu rhythms, Neuronal activity in motor cortex and related areas, Stimulus related potentials - Visual Evoked Potentials – P300 Event related potentials, cognitive tasks related potentials.		CO2
UNIT III	**FEATURE EXTRACTION ALGORITHMS**	**9**
Data Processing, Time and space methods, Wavelet analysis, AR, MA, ARMA models, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Bandpass filtering,Template matching, Kalman filter - Linear and Non-Linear Features.		CO3
UNIT IV	**FEATURE TRANSLATION METHODS FOR BCI**	**9**
Classification techniques –Binary classification, Ensemble classification, Nearest Neighbour Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis		CO4
UNIT V	**APPLICATIONS OF BCI**	9
Case Studies - Invasive BCIs: Restoration of hand motor functions, controlling prosthetic devices such as orthotic hands, Brain actuated control of mobile Robot, Functional restoration using Neuroprosthesis. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection, Ethics of Brain Computer Interfacing		CO5
	Total Hours:	45
	TEXTBOOKS	
1.	Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2013.	
2.	Jonathan Wolpaw, Elizabeth Winter Wolpaw, ―Brain Computer Interfaces: Principles and practice‖, Oxford University Press, USA, Edition 1, January 2012.	
	REFERENCE BOOKS	
1.	Ella Hassianien, A &Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.	
2.	Brendan Z. Allison, Stephen Dunne, Robert Leeb, José del R. Millán, "Towards Practical Brain Computer Interface", Springer,2013	
3.	Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010	
4.	Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57.	
5.	Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.	
6.	Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Understand various concept of BCI.	
CO2	Analyze the brain activation patterns and potentials	

CO3	Allocate functions appropriately to the human and to the machine. Study appropriate for feature extraction methods
CO4	Design a system using machine learning algorithms for translation.
CO5	Understand and analyze the different application of BCI

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	3	2	1	-	-	-	-	-	-	1	2	2	2	3
CO2	3	3	3	2	3	-	-	-	-	-	-	1	2	2	2	3
CO3	3	3	2	2	3	-	-	-	-	-	-	2	2	2	2	3
CO4	3	3	2	2	2	-	-	-	-	-	-	3	2	2	2	3
CO5	3	3	3	2	3	-	-	-	-	-	-	3	2	2	2	3

VERTICAL – IV

EC4641	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the mathematical description and modelling of discrete time random signals.
- To familiar with important theorems and random signal processing algorithms.
- To learns relevant figures of merit such as power, energy, bias and consistency.
- To conversant with estimation, prediction, filtering concepts and techniques.

UNIT I	DISCRETE RANDOM SIGNAL PROCESSING	9
Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Autocorrelation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records, Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.		CO1

UNITII	SPECTRUM ESTIMATION	9
Bias and Consistency of estimators - non-parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.		CO2

UNIT III	SIGNAL MODELING	9
Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.		CO3

UNIT IV	LINEAR ESTIMATION AND PREDICTION	9
Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.		CO4

UNIT V	ADAPTIVE FILTERS	9
FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.		CO5
Total Hours:		**45**

	TEXTBOOKS
1	Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc, Singapore, 2002
2	John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Prentice Hall of India, New Delhi, 2005
	REFERENCE BOOKS
1	Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons Inc., New York, 2006.
2	P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1992
3	S. Kay,” Modern spectrum Estimation theory and application”, Prentice Hall, Englehood Cliffs, NJ1988.
4	Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, Englehood Cliffs, NJ1986. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw-Hill, 2000.

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
CO2	Analyze non- parametric methods and parametric methods for spectral estimation
CO3	Analyze signal modeling techniques to discrete random signals
CO4	Apply linear estimation and prediction techniques to discrete random signals for signal separation, detection and estimation
CO5	Apply optimum filtering techniques for discrete random signals, the concepts of compressed sensing for signal processing application

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	2	-	-	-	-	2	2	3	2	1	1
CO2	3	3	3	3	2	2	-	-	-	-	2	2	3	2	1	1
CO3	3	3	3	3	2	2	-	-	-	-	2	2	3	2	1	1
CO4	3	3	3	3	2	2	-	-	-	-	2	2	3	2	1	1
CO5	3	2	2	2	3	2	-	-	-	-	1	2	1	3	1	1

EC4642	**IMAGE PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To familiarize the fundamental of digital images.
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression, representation, and object detection methods

UNIT1	**FUNDAMENTALS OF DIGITAL IMAGE PROCESSING**	**9**

Introduction to Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Image Sensors - Relationships between pixels - Color image fundamentals - RGB, HSI models, Lab Model, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, Wavelet

UNIT II	**IMAGE ENHANCEMENT**	**9**

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

UNIT III	**IMAGE RESTORATION**	**9**

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

UNIT IV	**IMAGE SEGMENTATION AND PROCESSING**	**9**

Point, Line and Edge segmentation, Edge detection - Sobel – Canny, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm – Multi-Resolution and Multi-scale Analysis, Color Image Processing		
UNIT V	**IMAGE COMPRESSION, REPRESENTATION AND OBJECT DETECTION**	**9**
Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, JPEG 2000, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Principal components - Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching – Structural Methods - Introduction to Object Recognition using CNN Algorithms		
	Total Hours:	45

	TEXTBOOKS
1.	Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson, Third Edition, 2010.
2.	Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 2002.
	REFERENCE BOOKS
1	Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
2	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
3	D,E. Dudgeon and RM. Mersereau, 'Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
4	William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002
5	Milan Sonka et al 'Image processing, analysis and machine vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement
CO3	Understand the restoration concepts and filtering techniques.
CO4	Understand the concepts of segmentation and processing
CO5	Learn the basics of features extraction, compression, representation, and object detection methods on images

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	2	2	3	2	-	-	-	-	1	2	**2**	**3**	**3**	**2**
CO2	3	3	2	2	3	2	-	-	-	-	1	2	**2**	**3**	**3**	**2**
CO3	3	3	2	2	3	2	-	-	-	-	1	2	**2**	**3**	**3**	**2**
CO4	3	3	2	2	3	2	-	-	-	-	1	2	**2**	**3**	**3**	**2**
CO5	3	3	2	2	3	2	-	-	-	-	1	2	**2**	**3**	**3**	**2**

EC4643	SPEECH PROCESSING	L	T	P	C
		2	0	2	3

OBJECTIVES:

The student should be made:

- To understand the speech production mechanism and the various speech analysis techniques and speech models
- To understand the speech compression techniques
- To understand the speech recognition techniques
- To know the speaker recognition and text to speech synthesis techniques

UNIT I	INTRODUCTION TO SPEECH SIGNAL CHARACTERISTICS & ANALYSIS	11
Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods. Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.		CO1
UNIT II	**DATA COMPRESSION**	**11**
Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization-Linear predictive coding(LPC)-Code excited Linear predictive Coding(CELP)		CO2
UNIT III	**SPEECH RECOGNITION**	**11**
LPC for speech recognition- Hidden Markov Model (HMM)-training procedure for HMM-sub word unit model based on HMM-language models for large vocabulary speech recognition - Overall recognition system based on subword units - Context dependent subword units- Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues - Semantic post processor for speech recognition		CO3
UNIT IV	**SPEAKER RECOGNITION**	**6**
Acoustic parameters for speaker verification-Feature space for speaker recognition-similarity measures-Text dependent speaker verification-Text independent speaker verification techniques		CO4
UNIT V	**SPEAKER RECOGNITION AND TEXT TO SPEECH SYNTHESIS**	**6**
Textto speech synthesis(TTS)-Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody- Applications and present status.		CO5
PRACTICAL EXERCISES: 1. Write a MATLAB Program to classify voiced and unvoiced segment of speech using various time- domain measures 2. Write a MATLAB Program to calculate the MFCC for a speech signal 3. Implement ITU-T G.722 Speech encoder in MATLAB 4. Write a MATLAB Program to implement Wiener Filters for Noise Reduction 5. Design a speech emotion recognition system using DCT and WPT in MATLAB HARDWARE & SOFTWARE SUPPORT TOOLS: • Personal Computer with MATLAB • Microphone and Speakers		**15**
	Total Hours:	**60**
	TEXTBOOKS	

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.	BenGold and Nelson Morgan―Speech and Audio signal processing-processing and perception of speech and music, JohnWiley and sons 2006.
3.	Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education.
	REFERENCE BOOKS
1.	Lawrence Rabiner,Biiing and–Hwang Juang andB.Yegnanarayana ―Fundamentals of Speech Recognition, Pearson Education, 2009.
2.	Claudio Becchetti and Lucio Prina Ricotti,―Speech Recognition, JohnWiley and Sons,1999.
3.	Donglos Oshanhnessy―Speech Communication: Human and Machine ―, 2ndEd. University press2001.
4.	Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand characteristics of speech signals.
CO2	Develop techniques for speech compression.
CO3	Configure speech recognition techniques.
CO4	Create systems for recognizing speakers.
CO5	Design text to speech synthesis systems.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	1	1	2	-	-	-	-	-	2	3	2	2	1
CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2	1
CO4	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2	1
CO5	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2	1

EC4644	**SOFTWARE DEFINED RADIO**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

- To gain knowledge on the basics of Software Defined Radio.
- To attain knowledge in the hardware and software details of SDR.
- To understand the standardization needed for SDR.
- To give an insight about the application of SDR.

UNIT I	**INTRODUCTION TO SOFTWARE DEFINED RADIO**	**9**
Conceptual SDR with its architecture, Networking with SDR, SDR processors architecture, SDR Software related environs for SDR, Basic regulations for RF, Demerits of SDR		CO1
UNIT II	**HARDWARE CENTRIC SDR**	**9**
Components of SDR – AD9363 , Zynq , Linux Industrial Input/Output , Strategies for for development in Matlab.		CO2
UNIT III	**SOFTWARE CENTRIC SDR**	**9**
GNU Radio – Signal Processing Blocks, Scheduler, GR development Frame, open source SCA implementation, Front end for Software Radio		CO3

UNIT IV	**SDR STANDARDIZATION**	**9**
Software Communication and Architecture and JTRS, STRS, Physical Layer description – Development Approach, configuration and XML, Data Formats – VITA radio Transport, Digital RF, SDDS, Common public Radio Interface.		CO4
UNIT V	**APPLICATIONS OF SOFTWARE DEFINED RADIO**	**9**
Cognitive Radio – Bumblebee Behavioral Model, Reinforcement Learning, Vehicular Networking.		CO5
PRACTICAL EXERCISES: 1. Study of SDR hardware kit 2. Design and Implementation of digital modulation schemes using SDR 3. Implementation of synchronization techniques using SDR 4. Channel Coding Techniques using SDR 5. Study of channel estimation techniques using SDR 6. Study of MIMO concepts using SDR		15
	Total Hours:	60
	TEXTBOOKS	
1.	Travis F Collins,Robin Getz, Di Pu and Alexander M. Wyglinski, "Software Defined Radio for Engineers", British Library Cataloguing in Publication Data, Copyright 2018. (Unit I,II,V)	
2.	Eugene Grayver, "Implementing Software Defined Radio" , Springer Nature, 2013. (Unit III,IV)	
	REFERENCE BOOKS	
1.	Simon Haykin ,"Cognitive Dynamic Systems: Perception-action Cycle, Radar and Radio" , Cambridge University Press, 22-Mar-2012.	
2.	Joseph MitolaIII, "Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000.	
3.	Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Understand the basics of Software Defined Radio.	
CO2	Describe the hardware requirements for the SDR implementation.	
CO3	Describe the software requirements for SDR implementation.	
CO4	Characterize the standardization of SDR.	
CO5	Understand the various application of SDR.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	1	1	1	-	-	-	-	-	2	3	2	2	2
CO2	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	1
CO3	3	3	3	2	3	2	-	-	-	-	-	2	2	2	2	1
CO4	3	3	3	2	2	2	-	-	-	-	-	2	2	3	2	1
CO5	3	3	3	2	2	2	-	-	-	-	-	3	3	3	2	2

EC4645	DSP PROCESSOR ARCHITECTURE AND PROGRAMMING	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand the Digital Signal Processor basics
- To familiar with Third generation DSP Architecture and programming skills.
- To understand the Advanced DSP architectures and some applications.

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.		CO1
UNITII	**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.		CO2
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.		CO3,
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.		CO4
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.		CO5,

PRACTICAL EXERCISES: **15**

1. Real-Time Sine Wave Generation
2. Programming examples using C, Assembly and linear assembly
3. Implementation of moving average filter
4. FIR implementation with a Pseudorandom noise sequence as input to a filter
5. Fixed point implementation of IIR filter
6. FFT of Real-Time input signal

HARDWARE & SOFTWARE SUPPORT TOOLS:

- TMS320C54xx/TMS320C67xx DSP Development board
- Code Composer Studio (CCS)
- Function Generator and Digital Storage Oscilloscope
- Microphone and speaker

Total Hours: 60

TEXT BOOKS

1. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture, Programming and Application" Tata McGraw – Hill Publishing Company Limited, New Delhi, 2003.
2. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson, Fourth Edition, 2007

	REFERENCE BOOKS
1.	Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012 .
2.	RulphChassaing and Donald Reay, Digital Signal Processing and Applications with the C6713 and C6416 DSK, John Wiley & Sons, Inc., Publication, 2012 (Reprint).
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Conceptualize and evaluate the Digital signal processor.
CO2	Describe the basic principle of Programmable architecture.
CO3	Demonstrate their proficiency with Programming the DSP Processor for signal processing applications, On-chip Peripherals, and Instruction set.
CO4	Discuss, compare, and determine the most appropriate sophisticated DSP processor for real-time processing applications.
CO5	Apply and assess the Advanced Programmable DSP processor paradigm.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	2	3	1	2	2	-	-	-	-	-	2	2	2	2	1
CO2	3	3	3	2	2	2	-	-	-	-	-	2	2	2	3	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	2	2	3	1
CO4	3	3	2	2	2	2	-	-	-	-	-	2	2	2	3	1
CO5	3	3	3	2	3	2	-	-	-	-	-	2	2	2	3	1

EC4646	**COMPUTER VISION FOR ROBOTICS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

OBJECTIVES:

- To learn fundamental image processing techniques required for computer vision
- To be familiar with Linear Filters.
- To learn about the geometry of multiple views.
- To learn about segmentation.
- To Develop applications using computer vision techniques.

UNIT I	**CAMERAS**	**9**
Cameras: Pinhole Cameras- **Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases -**Sources, Shadows, And Shading:** Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Inter reflections: Global Shading Models-**Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.		

UNIT II	**LINEAR FILTERS**	**9**
Linear Filters: Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and ourier Transforms, Sampling and Aliasing, Filters as Templates- **Edge Detection:** Noise, Estimating Derivatives, Detecting Edges-**Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.		
UNIT III	**THE GEOMETRY OF MULTIPLE VIEWS**	**9**
The Geometry of Multiple Views: Two Views- **Stereopsis:** Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras- **Segmentation by Clustering:**Segmentation, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering.		
UNIT IV	**SEGMENTATION BY FITTING A MODEL**	**9**
Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness-**Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice-**Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples.		
UNIT V	**GEOMETRIC APPLICATIONS**	**9**
Geometric Camera Models: Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations,**Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization **Model- Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces and Alignment.		
PRACTICAL EXERCISES **Software needed:** OpenCV computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or or equivalent **LABORATORY EXPERIMENTS:** • OpenCV Installation and working with Python • Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Bolb detection • Image Annotation – Drawing lines, text circle, rectangle, ellipse on images • Image Enhancement - Understanding Color spaces, color space conversion, Histogram equalization, Convolution, Image smoothing, Gradients, Edge Detection • Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment • Image segmentation using Graph cut / Grabcut • Camera Calibration with circular grid • Pose Estimation • 3D Reconstruction – Creating Depth map from stereo images		15

• Object Detection and Tracking using Kalman Filter, Camshift **Reference:** 1. docs.opencv.org 2. https://opencv.org/opencv-free-course/	
Total Hours:	45

	TEXTBOOKS
1.	David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.
2.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
	REFERENCE BOOKS
1.	E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier
2.	(Academic Press)
3.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced
4.	Robotics, Volume 118, Second Edition, 2016 David Forsyth and Jean Ponce, Computer Vision: A modern Approach, Prentice Hall India 2004 Klafter, Chmielewski and Negin, Robotic Engineering - An Integrated approach,, PHI, 1st edition, 2009.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Implement fundamental image processing techniques required for computer vision
CO2	Perform shape analysis and Implement boundary tracking techniques
CO3	Apply chain codes and other region descriptors and Hough Transform for line, circle, and ellipse detections
CO4	Implement motion related techniques
CO5	Develop applications using computer vision techniques

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	3	-	-	-	-	-	2	3	3	2	2
CO2	3	3	3	3	2	3	-	-	-	-	-	2	3	3	2	2
CO3	3	3	3	3	2	3	-	-	-	-	-	2	3	3	2	2
CO4	3	3	3	3	2	3	-	-	-	-	-	2	3	3	2	2
CO5	3	3	3	3	2	3	-	-	-	-	-	3	3	3	3	2

VERTICAL – V

EC4651	**RF TRANSCEIVERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the basic principles of a radio frequency system
- To understand the importance of different performance measures in RF design and the pros and cons of the different RF transceiver architectures
- To understand the principles and trade-offs involved in the design of RF systems involving amplifiers, oscillators, mixers and synthesizers.

UNIT I	**FUNDAMENTALS OF RADIO FREQUENCY SYSTEM**	**9**
Introduction to Linear systems and Non-linear system, Essential variables: Signal to Noise Ratio, Characteristic impedance, S-parameters, Gain, Noise figure, Impedance matching and Decibels.		CO1

General Considerations of base band digital signaling: Pass band signals, Sampling, Average and RMS value, Peak value, Short term variations, modulation schemes, filters, Intersymbol Interference, ACLR and ACPR, EVM, BER, dynamic range.		
UNITII	**RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS**	**9**
Architecture of Super heterodyne, Zero Intermediate Frequency, Low Intermediate Frequency structures and harmonic sampling techniques. Transmitter and Receiver System Analysis and Design, Cognitive Radio Applications for front end analog systems: Interference, Near, In-band & wide-band considerations.		CO2
UNIT III	**AMPLIFIER MODELING AND ANALYSIS**	**9**
Noise: Types of Noise and amplifier noise model in Radio frequency device, performance of noisy model systems in cascade mode, Sensitivity and selectivity of RF receiver. Non-Linearity: Amplifier power transfer curve, Effects of Non-linearity-Harmonic distortions, gain compression-expansive and compressive, Cross modulation, AM-AM, AM-PM, polynomial approximations, Saleh model, Wiener model and Hammerstein model, inter modulation, Figure of Merit, cascaded nonlinear stages.		CO3
UNIT IV	**MIXER AND OSCILLATOR MODELING AND ANALYSIS**	**9**
Mixers: Fundamentals and principles of Mixer and mechanism of frequency translation and its application, frequency inversion, image frequencies, spurious calculations. Oscillators: Effects of oscillator error in typical applications – oscillator phase error, phase noise, jitter, frequency accuracy, and oscillator realizations: Frequency synthesizers, Direct digital frequency synthesizer and digital signal generator.		CO4
UNIT V	**APPLICATIONS OF RADIO FREQUENCY SYSTEMS DESIGN**	**9**
Multimode and multiband Super heterodyne transceiver – software defined front-ends-system level considerations, wideband LO generation, building blocks and isolating techniques, Direct conversion transceiver: receiver system and transmitter system design.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Qizheng Gu, "RF System Design of Transceivers for Wireless Communications", Springer, 2005.
2.	Kevin McClaning, "Wireless Receiver Design for Digital Communications" ,Yes Dee Publications, 2012
	REFERENCE BOOKS
1.	M C Jeruchim, P Balapan and K S Shanmugam, "Simulation of Communication systems: Modeling, Methodology and Techniques", Kluwer Academic/Plenum Publishers, 2 nd Edition, 2000.
2.	Jan Crols, Michiel Steyaert, "CMOS Wireless Transceiver Design", Kluwer Academic Publishers, 1997.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the specifications of transceiver modules
CO2	Ability to understand pros and cons of transceiver architectures and their associated design considerations
CO3	Analyze the impact of noise and amplifier non-linearity of amplification modules
CO4	To get exposure and learn about spurs and generation principles during signal generation and frequency translations
CO5	The case study will reinforce the understanding of transceiver systems and aid to select specification parameters selections

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3	
COs	**PROGRAMME OUTCOMES**	**PROGRAMME SPECIFIC OUTCOMES**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	2	-	-	-	-	-	-	-	2	2	2	2
CO2	3	3	2	3	2	-	-	-	-	-	-	-	2	2	2	2
CO3	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2	2
CO4	3	3	3	3	2	-	-	-	-	-	-	1	2	2	2	2
CO5	3	3	3	2	2	-	-	-	-	-	-	1	3	2	2	2

EC4652	**Networks and Security**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To learn the Network Models and Datalink layer functions.
- To understand routing and protocolsin the Network Layer.
- To explore methods of communication and congestion control by the Transport Layer.
- To study the Network Security Mechanisms.
- To learn various hardware security attacks and their countermeasures

UNIT I	**OVERVIEW OF NETWROKS AND LINK LAYER FUNCTIONS**	**9**

Introduction to Communication Networks and its Attributes – Different models of Networks – OSI, TCP/IP, Four types of addressing methods – Function of Link layer– Error Detection and Correction – Ethernet(802.3)- Wireless LAN – IEEE 802.11, Bluetooth – Different types of control protocols – HDLC – PPP-P2MP

UNIT II	**PROTOCOLS IN NETWORK LAYERS**	**9**

Network Layer – 32 Bit addressing – Types of Protocols (IP, ICMP and Mobile IP) Routing methods – Intradomain and Interdomain Routing Protocols – 128 bit addressing – IPv6 – Datagram Format – Conversion of IPv4 to IPv6.

UNIT III	**TRANSPORT AND APPLICATION LAYERS**	**9**

Transport Layer Protocols – UDP and TCP Connection and State Transition Diagram - Congestion Control and Techniques of Congestion Avoidance (DEC bit, RED)- QoS - Application Layer Paradigms – Programming based on Client Server model – Application of Upper Layer - Domain Name System – World Wide Web, HTTP, Electronic Mail, Telnet.

UNIT IV	**NETWORK SECURITY**	**9**

Security in OSI Architecture – Types of Attacks – Security Services and Mechanisms – Introduction to Cryptography -Encryption –Decryption – Data Encryption Standard - Advanced Encryption Standard – RC4-Public Key Cryptosystems – RSA Algorithm – Hash Functions – Secure Hash Algorithm – Digital Signature Algorithm. IPsec

UNIT V	**HARDWARE SECURITY**	**9**

Introduction to hardware security, Hardware Trojans, Side – Channel Attacks – Physical Attacks and Countermeasures – Design for Security. Introduction to Blockchain Technology. Challenges in Blockchain Technology.

	Total Hours	**45**

TEXT BOOKS

1. Behrouz.A.Forouzan, Data Communication and Networking, Fifth Edition, TMH, 2017.(Unit – I,II,III)
2. William Stallings, Cryptography and Network Security, Seventh Edition, Pearson Education, 2017(Unit- IV)
3. BhuniaSwarup, Hardware Security –A Hands On Approach,Morgan Kaufmann, First edition, 2018. (Unit – V).

REFERENCE BOOKS

1 James.F.Kurose and Keith.W.Ross, Computer Networking – A Top – Down Approach, Sixth Edition, Pearson, 2017.

2	Doughlas .E.Comer, Computer Networks and Internets with Internet Applications, Fourth Edition, Pearson Education, 2008.
CO	**COURSE OUTCOMES:**
CO1	Explain the Network Models, layers and functions.
CO2	Categorize and classify the routing protocols.
CO3	List the functions of the transport and application layer.
CO4	Evaluate and choose the network security mechanisms.
CO5	Discuss the hardware security attacks and countermeasures.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	2	2	-	-	-	2	2	3	3	3	1
CO2	2	2	2	2	2	2	2	-	-	-	2	2	3	3	3	1
CO3	2	2	2	2	2	3	2	-	-	-	2	2	3	3	3	1
CO4	2	2	2	2	2	3	2	-	-	-	2	2	3	3	3	1
CO5	2	2	2	2	2	3	2	-	-	-	2	2	3	3	3	1

EC4653	**LOW POWER INTEGRATED CIRCUIT DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

The students should be made to:

- Known the low power low voltage VLSI design
- Understand the low power CMOS architectures.
- Design low power circuit.
- Learn about Low power ROMs and RAMs.
- Apply low power design in specific applications

UNIT I	**OVERVIEW OF LOW POWER DESIGN**	**9**
Introduction to Low Power Circuit Design, Power Dissipation -Sources–Short Circuit and Switching Power Dissipation, Power Dissipation of Leakage and Glitching, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation		CO1
UNIT II	**LOW-POWER VOLTAGE SCALING AND CMOS ARCHITECTURES**	**9**
Introduction to Low-Power Design through Voltage Scaling, Architectural Level Approach – Parallel and Pipelining Processing Approaches. Low power design of Variable-Threshold CMOS (VTCMOS) and Multiple- Threshold CMOS (MTCMOS), Design and approaches of Pipelining, Parallel Processing and Power Gating		CO2
UNIT III	**LOW-POWER CIRCUIT DESIGN**	**9**
Static CMOS - Logic Power Estimation and Minimization, Power Minimization in Dynamic CMOS Multiple-Threshold CMOS, Variable Supply and Threshold Voltages , Leakage Managing , Subthreshold Circuit Design, Silicon-on-Insulator (SOI) Technologies, Energy Recovery, Interconnect Power Estimation and Management		CO3
UNIT IV	**LOW POWER ROMs AND RAMs**	**9**
Future Trend and Development of ROMs- Low-Power ROM and SRAM Technologies, Basics of SRAM and DRAM, Future Trend and Development of DRAM., Memory Cell-Precharge and Equalization Circuit, Self-Refresh Circuit,		CO4
UNIT V	**APPLICATIONS:LOW POWER DESIGN**	**9**
Applications of Low power IC in multimedia, computing, and communications, Low power Applications in Sensors and Sensor Networks, Low power synthesis		CO5

	Total Hours:	**45**
	TEXTBOOKS	
1.	CMOS Digital Integrated Circuits – Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.	
2.	Roy, K. and Prasad, S., Low Power CMOS VLSI: Circuit Design	
	REFERENCE BOOKS	
1.	Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.	
2.	Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.	
3.	Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press, 2002.	
4.	Kassakian, J., Schlecht, M., and Verghese, G., Principles of Power Electronics.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Known the fundamentals of Low power Circuit design	
CO2	Understand the need of CMOS architectures.	
CO3	Attain the knowledge of low power circuit design.	
CO4	Known the design of Low-Voltage Low-Power Memories.	
CO5	Attain the knowledge of low power applications	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	2	3	-	-	-	-	-	1	2	1	1	1
CO2	3	3	2	2	2	3	-	-	-	-	-	1	2	3	1	1
CO3	2	3	2	3	2	3	-	-	-	-	-	1	2	2	1	1
CO4	2	3	2	2	3	3	-	-	-	-	-	2	2	3	1	2
CO5	3	3	2	2	2	3	-	-	-	-	-	2	2	1	2	1

EC4654	**MICs and RF System Design**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the fundamentals of RF design and Microwave Integrated Circuits.
- To understand the various components of RF system for Wireless Communications.
- To know the basic techniques needed for analysis of RF systems

UNIT I	**CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES**	**9**
CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.		**CO1**
UNIT II	**IMPEDANCE MATCHING AND AMPLIFIERS**	**9**

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match, Single ended and Differential schemes.		**CO2**
UNIT III	**FEEDBACK SYSTEMS AND POWER AMPLIFIERS**	**9**
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, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations		**CO3**
UNIT IV	**RF FILTERS, OSCILLATORS, MIXERS**	**9**
Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phases locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.		**CO4**
UNIT V	**MIC COMPONENTS**	**9**
Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components-Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS:

1. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
2. T. Lee,"Design of CMOS RF Integrated Circuits", Cambridge, 2004.

REFERENCES:

1. Igor Minin, "Microwave and millimeter wave technologies modern UWB antennas and equipment", In-Tech publication, 2010.

OUTCOMES:

Upon completion of the course, the student should be able to

CO1	Discuss the basic concepts of RF and MIC.
CO2	Understand the various components of RF systems.
CO3	Discuss the operation of RF circuits.
CO4	Understand the operation of Microwave components.
CO5	Discuss various MIC components.

MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3

COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	3	2	2	1	3	-	-	-	3	1	2	2
CO2	3	3	3	2	3	2	2	1	2	-	-	-	2	1	3	3
CO3	3	3	2	2	2	1	2	1	2	-	-	-	2	2	2	2
CO4	3	3	2	2	2	1	1	1	1	-	-	-	3	1	3	3
CO5	3	3	3	3	2	1	2	1	3	-	-	-	3	1	3	3

EC4655	**EMI/EMC PRE COMPLIANCE TESTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To familiarize with the basics that are essential for electronics industry in the field of EMI / EMC
- To understand EMI sources and its measurements
- To understand the various techniques for electromagnetic compatibility.
- Acquire broad knowledge of various EM radiation measurement techniques.
- Model a given electromagnetic environment/system so as to comply with the standards.

UNIT I	**EMC FUNDAMENTALS**	**9**
Definition of EMI and EMC, Sources and Simulators, Propagation Methods- Basic Aspects of EMI in System Environment, Electrical Noise Sources, Common-Mode and Differential-Mode Currents, Power and/or Return Bounce, Identification of EMI Hot Spot, RF Current Return and Flux Cancellation, Loop Area between Circuit and components, Primary Grounding, Filtering, Shielding		CO1
UNIT II	**EMC STANDARD AND EMC MEASUREMENTS**	**9**
Overview of EMC Standards, Radiated and Conducted Emission (RE/CE) Standards, Radiated and Conducted Immunity (RI/CI) Standards, Electrostatic Discharge (ESD) Standards, Overview of EMC Measurements, Testing Equipment, Radiated Emission Test Setup, Measurement of Signals and Noise, Interpretation of Measurement Results		CO2
UNIT III	**PCB TRACE ROUTING AND TERMINATION**	**9**
Typical PCB Trace Topologies, Trace Routing Design Guidelines, Routing Differential Pair Signals, Layer Jumping – Use of Vias, Routing over a Split Plane, Fundamental Concepts of Trace Termination, Termination Methodologies and Implementation- Types of Grounds, Function of a Ground, Grounds Separation and Isolation, Single-Point, Multi-Point and Hybrid Grounds, Internal Cables and Connectors Grounding, Common-Mode and Differential-Mode Filtering, Basic Filter Component Characteristics, Filtering Guidelines		CO3
UNIT IV	**SHIELDING AND ELECTRICAL GASKETS**	**9**
Transmission Line Theory of Shielding, Absorption Loss, Reflection Loss, Shielding Effectiveness, Shielding Materials, Apertures in Shielded Walls, Waveguide below Cut-off, The Need for Gaskets, Common Gaskets Material Use, Properties and Characteristics of RF Gaskets- EMC/EMI Modelling Techniques and Applications, Virtual EMC Lab, New Radiation Testing Technology – from Near-field Scanning to Far-field Prediction, Novel Radiation Mitigations Design		CO4
UNIT V	**PROJECTS USING CST STUDIO SUITE**	**9**
Common Impedance Coupling Simulation, Lightning Strike Analysis, Emissions Simulation via Cascading, Electrostatic Discharge, Simulating Shielding Effectiveness, Simulating Conducted Emissions from a Motor Control, Simulating Conducted Emissions from a DC/DC Converter		CO5
	Total Hours:	

	TEXTBOOKS
1.	Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons, 2009
2.	Ralph Morrison, "Grounding and Shielding: Circuits and Interference”, John Wiley & Sons
	REFERENCE BOOKS
1.	Dragan Poljak, "Advanced Modeling in Computational Electromagnetic Compatibility”, John Wiley & Sons.
2.	Dipak L. Sengupta and Valdis V. Liepa,"Applied Electromagnetics and Electromagnetic Compatibility”, John Wiley & Sons
3.	“Electromagnetic Interference and Compatibility”, IMPACT series, IIT-Delhi, Modules1-9
4.	EMI/EMC Testing, Society of Applied Microwave Electronics Engineering and Research Sameer
	COURSE OUTCOMES: After completing this course, the students will be able to

CO1	Designing electronic systems that function without errors or problems related to electromagnetic compatibility
CO2	Real-world EMC design constraints and make appropriate tradeoffs to achieve the most cost-effective design that meets all requirements.
CO3	Concepts of PCB tracing, termination and implementation
CO4	Understanding the various aspects of shielding.
CO5	Acquire broad knowledge of various EM radiation measurement techniques.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	1	1	3	-	-	-	-	-	2	3	1	2	1
CO2	3	2	1	2	2	2	-	-	-	-	-	2	3	3	2	1
CO3	3	3	2	2	2	2	-	-	-	-	-	3	3	2	2	1
CO4	3	3	3	2	2	2	-	-	-	-	-	2	2	3	2	2
CO5	3	3	3	2	2	2	-	-	-	-	-	2	2	1	2	1

EC4656	**CAD FOR VLSI CIRCUITS**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVE

- To familiarize with the basics that are essential for learning CAD tools for VLSI.
- To understand VLSI design methodologies and design rules for digital circuits.
- Discuss about design flow organization for VLSI, the standard cell based synthesis methodologies for digital VLSI, floor planning and placement principles
- To acquire knowledge of switch level and Gate level modelling and Simulation

UNIT I	**VLSI DESIGN TECHNIQUES**	**9**
VLSI Design methodologies introduction - Data structures and algorithms review - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable problems - general methods for combinatorial optimization.		**CO1**
UNIT II	**LAYOUT DESIGN RULES**	**9**
Layout - Design rules - problem formulation - algorithms for constraint graph compaction - placement and partitioning - Circuit representation - Placement algorithms – partitioning		**CO2**
UNIT III	**FLOOR PLANNING**	**9**
Concepts of floor planning - shape functions and floor plan sizing - Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing.		**CO3**
UNIT IV	**SIMULATION**	**9**
Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis.		**CO4**
UNIT V	**MODELLING AND SYNTHESIS**	**9**
High level Synthesis - Hardware models - Internal representation - Allocation assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.		**CO5**
		TOTAL : 45 Hours

TEXT BOOKS

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons,2002.

REFERENCE BOOKS

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers,2002.

COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Ability to understand the basics for learning CAD tool for VLSI
CO2	Apply VLSI design methodologies and design rules for digital circuits.
CO3	Use floor planning and rooting concepts for digital circuits.
CO4	Apply switch level and Gate level modelling and Simulation.
CO5	Implement high level logic synthesis and scheduling.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	-	-	-	-	-	1	1	1	1	1	1
CO2	3	3	2	2	-	-	-	-	-	-	1	1	2	1	1	1
CO3	3	3	3	3	3	-	-	-	-	-	3	3	2	1	1	1
CO4	3	3	3	3	3	-	-	-	-	-	1	1	2	1	1	1
CO5	3	3	3	3	-	-	-	-	-	-	3	3	2	2	1	1

PROFESSIONAL ELECTIVE VI

EC4861	ADVANCED COMMUNICATION TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students should be made to:

- To understand the basics of MIMO Channels.
- Understand Concepts of MIMO diversity and spatial multiplexing.
- Learn Massive MIMO system
- Know millimeter wave communication
- Applications of MIMO to machine learning

UNIT I	REVIEW OF MIMO CHANNEL CAPACITY	9
Introduction to MIMO channel models, extended and classical i.i.d. channels, Channel Models of Correlated and Frequency Selective channels, SISO Fading Communication Channels, MIMO channel capacity, Ergodic and outage capacity- constraints on the capacity and channel properties		CO1
UNIT II	**MIMO DIVERSITY AND SPATIAL MULTIPLEXING**	**9**
Diversity and channel knowledge, sources and forms of diversity, Analysis of Rayleigh fading. Space time code of Alamouti. Receivers of space-time, Trade-offs between diversity multiplexing and ML, ZF, MMSE, and Sphere decoding, BLAST receivers, and spatial multiplexing of MIMO.		CO2
UNIT III	**INTRODUCTION TO MASSIVE MIMO SYSTEM**	**9**
Massive MIMO includes point-to-point, virtual, and multiuse MIMO. Massive MIMO, a trade-off between energy and spectral efficiency, a propagation channel model, channel estimation, and uplink and downlink data transmission capacity limitations.		CO3
UNIT IV	**MILLIMETER WAVE (MMW) COMMUNICATION SYSTEMS**	**9**
Regulation of the use of the radio spectrum, channel propagation, MMW hardware technology, MMW architecture and mobility, Physical layer approaches - beam shaping, beam locating, duplex scheme, and transmission scheme.		CO4
UNIT V	**6G AND APPLICATIONS**	**9**

Key Enablers of 6G: Massive MIMO- Extremely Large Aperture, Intelligent Reflecting Surface (IRS), Energy Harvesting-Throughput and probability , Visible Light Communication, etc. Applications of machine learning: Modeling and estimate of channels shared spectrum sensing, Resource distribution (NOMA, mmWave massive MIMO).	**CO5**
Total Hours:	**45**

	TEXTBOOKS
1.	R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2.	MischaDohler, Jose F. Monserrat Afif Osseiran" 5G Mobile and Wireless Communication Technology", Cambridge University Press 2016.
	REFERENCE BOOKS
1.	Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press 2005.
2.	Theodore S.Rappaport, 'Wireless Communications", 2nd edition, Pearson Education, 2002.
3.	John G. Proakis, "Digital Communication", Fifth Edition, McGraw Hill Publication, 2008.
4.	M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection", Prentice Hall of India, New Delhi, 1995
5.	Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Springer Series in Wireless Technology
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Conceptually appreciate Information theoretic aspects of MIMO
CO2	MMO diversity and spatial multiplexing
CO3	Analyze Massive MIMO system.
CO4	Discuss millimeter wave communication
CO5	Applications of Machine Learning in 5G Wireless Communications.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	2	2	2	2	-	-	-	-	2	2	3	2	2	2
CO2	3	3	3	2	2	2	-	-	-	-	2	2	3	3	2	2
CO3	2	3	3	3	2	2	-	-	-	-	2	2	3	2	2	2
CO4	2	3	3	2	2	2	-	-	-	-	3	3	2	3	2	2
CO5	3	3	3	2	2	2	-	-	-	-	2	2	3	3	2	2

EC4862	WIRELESS BROADBAND NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the technical, economic and service advantages of next generation networks.
- To learn the basic architecture of a next generation network (NGN) with reference
- To understand NGN services
- To learn the role of Multimedia Sub-System (IMS), network attachment and admission control functions.
- To learn and compare the various methods of providing connection-oriented services over NGN.

UNIT I	INTRODUCTION TO WIRELESS NETWORKS	9
Overview of wireless Networks, Review of cellular standards, 1 G to 5 G Technology, migration and advancement of GSM architecture and CDMA architecture, WLAN – IEEE 802.11and Types of HIPERLAN, Bluetooth system architecture and protocol architecture, Wi-Fi		CO1
UNIT II	**WIRELESS PROTOCOLS**	**9**
Mobile network layer- Mobile IP- Fundamentals, procedures of data forwarding in mobile IP, Different version of IP, IP mobility management, IP addressing - DHCP, Mobile transport layer- Traditional TCP, congestion control Techniques, classical TCP improvements Indirect TCP, snooping TCP, Mobile TCP		CO2
UNIT III	**3G STANDARDS**	**9**
IMT-2000 - W-CDMA, CDMA 2000 – radio & network components, network structure, packet-data transport process flow, Channel Allocation, core network, Techniques in interference-mitigation, UMTS-services, types of interface in UMTS, about 3GPP, UTRAN – architecture, High Speed Packet Data-HSDPA,HSUPA.		CO3
UNIT IV	**4G AND LTE**	**9**
LTE-A – Introduction, Requirements and Challenges, network architectures – EPC, E- UTRAN architecture - mobility management, resource management, services, channel –Types of channel mapping , Data transfer in downlink/uplink , MAC control element, PDU packet formats, scheduling services, random access procedure.		CO4
UNIT V	**LAYER-LEVEL FUNCTIONS**	**9**
Wireless channels Characteristics - downlink/uplink physical layer, MAC scheme - frame structure, resource structure, mapping, synchronization, reference signals and channel estimation, SC-FDMA, interference cancellation –CoMP, Carrier aggregation, Services - multimedia broadcast/multicast, location-based services.		CO5
	Total Hours	**45**

	TEXTBOOKS
1	Vijay K.Garg, “Wireless Network Evolution- 2G & 3G” Pearson.
	REFERENCE BOOKS
1	Kaveh Pahlavan, “Principles of wireless networks”, Prentice-Hall of India, 2008.
2	Jochen H.Schiller, “Mobile Communications”, 2/e, Pearson, 2014.
	COURSE OUTCOMES : After completing this course, the students will be able to
CO1	Explain the advantages of next generation networks
CO2	Architecture of a next generation network (NGN) with reference
CO3	Understand NGN services
CO4	Evaluation of 4G network and its function
CO5	Discuss the different layer level functions.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3

COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	-	-	-	-	2	3	3	2	1	2
CO2	3	3	3	2	2	2	-	-	-	-	2	3	3	2	1	2
CO3	2	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO4	3	2	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO5	2	3	3	3	1	1	-	-	-	-	2	3	3	2	1	2

EC4863	SIGNAL INTEGRITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge of the fundamentals and significance of signal integrity.
- To Illustrate and minimize cross talk in unbounded conductive media.
- To investigate the different types of Di-Electric materials.
- To study differential cross talk and the CMOS transmission line model

UNIT I	Introduction to Signal Integrity	9
The significance of signal integrity: Computing Power: Past and Future-Basics-A new realm of bus design- Electromagnetic fundamentals for signal integrity: Maxwell equations - Common vector operators: Vector-Dot Product-Cross Product-Vector and Scalar Fields-Flux-Gradient-Divergence-Curl-Wave propagations: Wave Equation-Relation between E and H and the Transverse Electromagnetic mode-Time-Harmonic Fields-Propagation of time harmonic plane Waves		CO1
UNIT II	**Basics of electrostatics**	**9**
Electrostatics: Electrostatic Scalar Potential in terms of an Electric Field-Energy in and Electric Field-Capacitance-Energy stored in a Capacitor-Magneto statics: Magnetic Vector Potential-Inductance- Energy in a Magnetic Field-Power flow and the poynting vector: time Averaged Values- Reflections of electromagnetic waves: Plane Wave incident on a perfect conductor-Plane wave Incident on a Lossless Dielectric		CO2
UNIT III	**Signal integrity modelling and analysis**	**9**
Mutual inductance and capacitance: Mutual Inductance-Mutual Capacitance-Field Solvers-Coupledwave equation: Wave Equation Revisited-Coupled Wave Equations-Coupled line analysis: Impedance and Velocity-Coupled Noise-Modal analysis: Modal Decomposition-Modal Impedance and Velocity-Reconstructing the Signal-Modal Analysis-Modal Analysis of Lossy Lines- Cross talk minimization		CO3
UNIT IV	**Signal Propagation**	**9**
Unbounded conductive media- Signal propagation: Propagation constant for conductive media: Skin Depth- Transmission lines- Classic conductor model: DC Losses in conductors- Frequency-Dependent Resistance in Conductors -Frequency-Dependent Inductance-Power Loss in a Smooth Conductor		CO4
UNIT V	**Di-Electric Materials and Physical Transmission Line Model**	**9**
Di-electric materials- Removal of common mode noise-Differential Cross talk-Virtual reference plane-Propagation of model voltages common terminology- Differential signaling- Drawbacks: Physical Transmission Line Model - non ideal return paths-Vias-IO design consideration-Push-pull transmitter-CMOS receivers-ESSD protection circuits-On chip Termination.		CO5
	Total Hours	**45**

TEXTBOOKS

1. Stephen Hall, Howard L. Heck, "Advanced Signal Integrity for High-Speed Digital Designs", Wiley Publishers, Wiley-IEEE Press; 1 edition (21 September 2011).

2.	James Edgar Buchanan, " Signal and power integrity in digital systems: TTL, CMOS, andBiCMOS",McGraw-Hill,1996
	REFERENCE BOOKS
1.	Hall S.H., Heck H.L.: Advanced Signal Integrity for High-Speed Digital Designs. Wiley-IEEE Press, 2009.
2.	Caniggia S., Maradei F.: Signal Integrity and Radiated Emission of High-Speed Digital Systems. John Wiley & Sons, 2009.
	COURSE OUTCOMES:
	After completing this course, the students will be able to
CO1	Comprehend signal integrity principles in the design of high-speed circuits.
CO2	Demonstrate instances of electrostatics
CO3	Understand about signal integrity models.
CO4	Understand unbounded conductive media and signal propagation
CO5	Investigate various types of Dielectric materials and design high speed devices.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	3	2	2	1	2	-	-	-	-	-	2	3	2	2	1
CO2	3	3	2	2	1	2	-	-	-	-	-	2	3	2	2	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	1
CO4	3	3	2	2	2	2	-	-	-	-	-	2	2	2	2	1
CO5	3	3	3	2	2	2	-	-	-	-	-	2	2	2	3	1

EC4864	**SOFTWARE DEFINED NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To learn the basics of software defined networks.
- To understand the controllers and network virtualizations
- To study about the SDN Data planes and Programming.
- To study about the various applications of SDN.

UNIT I	**OVERVIEW OF SOFTWARE DEFINED NETWORKS**	**9**
Software Defined Networking (SDN) –History - Switching architecture and Modern Data Center –Need and working of SDN – Concepts of Centralized and Distributed Control and Data Planes.		CO1
UNIT II	**OPEN FLOW & CONTROLLERS WITH VIRTUALIZATION OF SDN**	**9**
North and South bound architecture – open flow with its drawbacks, SDN via APIs, SDN via Hypervisor- 111 Based Overlays, Open day light controllers and Floodlight controllers, Virtualization of network framework.		CO2
UNIT III	**SDN DATA PLANES**	**9**

SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE, Software and hardware based approaches-Programmable network hardware.		CO3
UNIT IV	**SDN PROGRAMMING**	**9**
SDNs Programming using Northbound Application Programming Interface, Current Languages and Tools, Different types of SDNs		CO4
UNIT V	**APPLICATIONS OF SDN**	**9**
Backbone Networks of Home automation Systems applications , Industrial automation Systems and Smart grids., Software-Defined Network in Hadoop , Software-Defined Optical Network (SD-ON)		CO5
	Total Hours	45

	TEXTBOOKS
1.	Paul Goransson and Chuck Black, ―Software Defined Networks: A Comprehensive Approach, First Edition, Morgan Kaufmann, 2014.
2.	Thomas D. Nadeau, Ken Gray, ―SDN: Software Defined Networks, O'Reilly Media, 2013.
	REFERENCE BOOKS
1.	Siamak Azodolmolky, ―Software Defined Networking with Open Flow, Packet Publishing, 2013.
2.	Vivek Tiwari, ―SDN and Open Flow for Beginners‖, Amazon Digital Services, Inc., 2013.
3.	Fei Hu, Editor, ―Network Innovation through Open Flow and SDN: Principles and Design, CRC Press, 2014.Networks, May 2006.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Analyze the evolution of software defined networks.
CO2	Express the various components of SDN and their uses.
CO3	Explain the use of SDN in the current networking scenario.
CO4	Understand about SDN Programming
CO5	Design and develop various applications of SDN.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	2	1	2	-	-	-	-	-	2	2	2	2	1
CO2	3	3	3	2	1	2	-	-	-	-	-	2	2	2	2	1
CO3	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	1
CO4	3	3	3	2	2	2	-	-	-	-	-	2	2	2	2	1
CO5	3	3	3	2	2	2	-	-	-	-	-	3	2	3	2	2

EC4865	MILLIMETER WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the channel behavior with millimeter wave communication systems
- To learn the working of millimeter wave devices and circuits
- To familiarize the enabling systems of millimeter wave communication system
- To analyze the antenna design techniques for millimeter wave communication

UNIT I	INTRODUCTION TO MILLIMETER WAVES	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	**MILLIMETER 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	**MILLIMETERWAVE COMMUNICATION SYSTEM**	**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	**MILLIMETER 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 MILLIMETER 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 Hours

TEXT BOOKS

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

REFERENCE BOOKS

1. Xiang, W; Zheng, K; Shen, X.S, "5G Mobile Communications: Springer", 2016.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Develop Channel model for millimeter wave communication system.
CO2	Understand the working of millimeter wave devices and circuits.
CO3	Understand the working of single and multicarrier modulation systems.
CO4	Apply MIMO Techniques in designing mmWave systems
CO5	Understand diversity and beamforming techniques and its uses in millimeter wave systems

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	-	3	-	-	-	-	-	-	1	-	2	2	1	1
CO2	3	3	3	3	2	3	2	-	-	1	-	-	2	2	1	1
CO3	3	3	3	3	2	-	-	-	-	-	-	-	2	2	1	1
CO4	3	3	3	3	2	-	2	-	-	-	-	-	2	2	1	1
CO5	3	3	3	3	2	-	2	-	-	-	-	-	2	2	1	1

EC4866	**PHOTONIC NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the importance of the backbone infrastructure.
- To familiarize the architectures and the protocol stack in use.
- To give thorough understanding about high frequency line, power and impedance measurements.
- To understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods.
- To know about the advancements in networking and switching domains and the future trends.

UNIT I	**COMPONENTS OF OPTICAL SYSTEMS**	**9**
Light Transmission using Optical Fibers – Loss in Optical Transmission, Optical bandwidth, limitations of Optical Systems, Nonlinear effects; Solitons; Components of optical networks – Circulators ,Couplers, Isolators, Filters, Multiplexers, Wavelength Converters. Optical Amplifiers, Switches.		CO1
UNIT II	**OPTICAL NETWORK FRAMEWORKS**	**9**
Telecommunications Network Architecture; SONET / SDH, Multiplexing-Second-Generation Optical Networks-Layered Architecture; Network Broadcasting – Topologies for Broadcast Networks, MAC Protocols, Beyond Transmission Links to protocols.		CO2
UNIT III	**WAVELENGTH ROUTING NETWORKS**	**9**
Optical layer, Nodes in Optical Network, Lightpath Topology Design, Routing and wavelength assignment, Optical Networks Traffic Grooming, Variations in Architecture-, Logically Routed Networks, Linear Light wave networks.		CO3
UNIT IV	**PACKET SWITCHING AND ACCESS NETWORKS**	**9**
Photonic Packet Switching – Optical Time Division Multiplexing, Bit Interleaving , Packet Interleaving , Optical AND Gates ,Synchronization, Tunable Delays, Optical Phase Lock Loop. Optical Access Network Architectures and OTDM networks, Network Architecture overview Switch-based networks, Broadcast OTDM networks, Contention Resolution Access Networks.		CO4
UNIT V	**DESIGN AND MANAGEMENT OF NETWORKS**	**9**
Transmission System Engineering – transmitter, receiver, System model, Power penalty, Optical amplifiers, Gain Saturation in EDFAs, Gain Equalization in EDFAs, Intrachannel Crosstalk, Interchannel Crosstalk, dispersion, Fiber Nonlinearities Wavelength stabilization, Design of Soliton Systems – Overall Design Considerations		CO5
	Total Hours	45

	TEXTBOOKS
1.	Photonics Optoelectronics (pb2017) Kakani S.L . Cbs publications
2.	Photonics : Optical Electronics in Modern Communications – by Variv Second Edition
	REFERENCE BOOKS

1.	Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perspective‖, Harcourt Asia Pte Ltd., Second Edition 2004.
2.	C. Siva Ram Moorthy and Mohan Gurusamy, ―WDM Optical Networks: Concept, Design and Algorithms‖, Prentice Hall of India, Ist Edition, 2002.
3.	Biswanath Mukherjee, ―Optical WDM Networks‖, Springer Series, 2006.
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Use the backbone infrastructure for our present and future communication needs.
CO2	Analyze the architectures and the protocol stack.
CO3	Compare the differences in the design of data plane, control plane, routing .
CO4	Acquiring knowledge in switching and accessing of Optical Networks.
CO5	Able to design transmission system.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	3	1	2	-	-	-	-	2	2	3	2	1	1
CO2	3	2	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO3	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO4	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO5	3	3	3	3	2	2	-	-	-	-	2	3	3	2	1	2

VERTICAL VII

EC4871	**ADHOC NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To provide introduction to Adhoc Networks
- To understand MAC protocols and classification.
- To understand routing protocols
- To illustrate security in Adhoc Networks
- To understand energy management

UNIT I	**INTRODUCTION TO ADHOC NETWORK**	**9**
Ad-hoc networks – definition, characteristics features, applications. Characteristics of wireless channel, ad-hoc mobility models: indoor and outdoormodels.		CO1
UNIT II	**MAC PROTOCOLS**	**9**
MAC Protocols - Design issues, goals and classification. Contention based protocols – with reservation, scheduling algorithms, protocols using directional antennas.		CO2
UNIT III	**ROUTING PROTOCOLS**	**9**
Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV) -QoS aware routing.		CO3
UNIT IV	**SECURITY**	**9**
Need for security in adhoc networks, Security issues in adhoc networks- issues and challenges, Key Distribution and management, network security attacks, secure routing protocols.		CO4
UNIT V	**ENERGY MANAGEMENT**	**9**

Management of Energy- battery management transmission power - system power schemes. QOS solutions		CO5
	TOTAL HOURS	**45**
	TEXT BOOKS	
1.	C. Siva Ram Murthy and B. S. Manoj, Ad hoc Wireless Networks Architecture and Protocols, 2nd edition, Pearson Edition, 2007.	
2.	Charles E. Perkins, Ad hoc Networking, Addison – Wesley, 2000.	
	REFERENCE BOOKS	
1.	Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, Mobile ad-hoc networking, Wiley-IEEE press, 2004.	
2.	Mohammad Ilyas, The handbook of ad-hoc wireless networks, CRC press, 2002.	
3.	T. Camp, J. Boleng, and V. Davies " A Survey of Mobility Models for Ad-hoc Network"	
4.	Research, "Wireless Commun, and Mobile Comp.. Special Issue on Mobile Ad-hoc Networking Research, Trends and Applications, Vol. 2, no. 5, 2002, pp. 483 – 502.	
5.	Fekri M.bduljalil and Shrikant K. Bodhe , " A survey of integrating IP mobility protocols and Mobile Ad-hoc networks", IEEE communication Survey and tutorials, no: 12007.	
CO	**COURSE OUTCOMES:**	
CO1	Acquire knowledge about Adhoc Networks	
CO2	Acquire knowledge about MAC protocols and classification.	
CO3	Understand routing protocols	
CO4	Know about security in Adhoc Networks	
CO5	Understand Energy Management in Adhoc Networks	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2	1	2	-	-	-	-	2	2	3	2	1	2
CO2	3	2	2	2	1	2	-	-	-	-	2	2	3	2	1	2
CO3	2	2	2	2	1	2	-	-	-	-	2	2	3	2	1	2
CO4	3	2	2	2	2	2	-	-	-	-	2	2	3	2	2	2
CO5	2	2	2	2	2	2	-	-	-	-	2	2	3	2	1	2

EC4872	**IoT BASED SYSTEMS DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
OBJECTIVES: • To study the characteristic of IoT Based system design • To understand the design of a IoT system • To study the various digital signaling techniques and multipath mitigation techniques.					
UNIT1	**INTRODUCTION TO INTERNET OF THINGS**				**9**

Definition of IOT - Characteristics of IoT - History of IoT – Evolution of IoT – Web 3.0 view of IoT– Study of IoT Enabling Technologies – Architecture of IOT based Systems -– Fog, Applications of Cloud and Edge in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates.		
UNIT II	**ARCHITECTURES OF IOT**	**9**
Introduction to Middleware technologies used in IoT system – Architectures of IoT systems - Horizontal Architecture Approach – SOA based IoT Middleware - Middleware architecture and Interoperability challenges of IoT-Protocols of RFID,WSN,SCADA,M2M - Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.		
UNIT III	**IOT NETWORKING PROTOCOLS**	**9**
IoT Access Technologies: Physical Layer of IoT and MAC layer concepts of IoT, Architecture, topology and Security of IEEE 802.15.4 – Advanced protocols like 802.15.4g, 802.15.4e, LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing Techniques in Low Power and Lossy Networks – Supervisory Control and Data Acquisition techniques of Application Transport Methods – Study of Application Layer Protocols like MQTT , CoAP – Dissemination and data Agression.		
UNIT IV	**TOOLS FOR IOT IMPLEMENTATION**	**9**
Introduction to Python, Basic programming concepts of Python, Python development tools like jupyter, co-lab - Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementation of IoT techniques using Python.		
UNIT V	**IoT BASED CASE STUDIES**	**9**
Various applications of IOT based based in Home automations – Design of IOT in Smart cities – Implementing in Environment – Case study of IOT based system in Logistics – Agriculture – Industry - Health and life style .		
	Total Hours:	45
	TEXTBOOKS	
1.	Honbo Zhou, “Internet of Things in the cloud:A middleware perspective”, CRC press, 2012.	
2.	Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-onApproach)”, VPT, 1 st Edition,	
	REFERENCE BOOKS	
1.	Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.	
2.	Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, “Internet of Things (IoT) in 5G Mobile Technologies” Springer International Publishing Switzerland 2016.	
3.	Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things” Springer-Verlag Berlin Heidelberg, 2011.	
	COURSE OUTCOMES: After completing this course, the students will be able to	
CO1	Articulate the main concepts, key technologies, strength and limitations of IoT	
CO2	Identify the architecture, infrastructure models of IoT.	
CO3	Analyze the networking and how the sensors are communicated in IoT .	

CO4	Analyze and develop tools for IoT implementation.
CO5	Identify and design the new models for market strategic interaction.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	2	2	2	3	1	2	-	-	-	-	2	2	3	3	2	2
CO2	3	3	3	2	1	2	-	-	-	-	2	2	3	3	3	2
CO3	3	3	2	2	1	2	-	-	-	-	2	2	2	3	3	2
CO4	2	2	2	2	1	2	-	-	-	-	2	2	3	3	2	2
CO5	3	3	2	2	2	2	-	-	-	-	1	2	3	3	3	2

EC4873	**WIRELESS SENSOR NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To understand the basics of Wireless Sensor Networks.
- To learn various fundamental and emerging protocols of all layers
- To study about the issues pertaining to major obstacles in establishment and efficient management of Wireless sensor networks.
- To understand the nature and applications of Wireless sensor networks.
- To understand various securities practices and protocols Wireless Sensor Networks.

UNIT I	**CHARACTERISTICS AND LAYERS OF WSN**	**9**
WSN Characteristics - WSNs Challenges– compare WSN vs Adhoc Networks - WSN architecture – sensor nodes Commercially available – EYES nodes, BT nodes, IRIS, Mica Mote, TelosB - WSNs Physical layer and transceiver design considerations, profile of Energy usage in WSN.		
UNIT II	**MEDIUM ACCESS CONTROL PROTOCOLS AND STANDARDS**	**9**
MAC protocols Fundamentals- WSN wakeup concepts and Low duty cycle protocols – Contention based protocols - Schedule-based protocols - Traffic-adaptive medium access protocol - Low-Rate WPAN(LR-WPANs) IEEE 802.15.4 MAC protocol.		
UNIT III	**ROUTING AND DATA GATHERING PROTOCOLS ROUTING**	**9**
Challenges in routing and Issues in design WSN – Data centric Routing, Flooding and gossiping – Sensor Protocol for Information via Negotiation – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – Hierarchical Routing - LEACH, Location Based Routing – GF, Real Time routing Protocols – TEEN, Data aggregation operations - Aggregation Techniques – TAG, Tiny DB.		
UNIT IV	**WSN OPERATING SYSTEMS**	**9**
WSNs Operating Systems - Design Issues Operating System - Classifications of Operating Systems – TinyOS – Mate – OSPM - EYES OS -PicOS – Tiny OS – NesC – Modules and Interfaces - Configurations - Generic Components - configuring Tiny OS using NesC, Emulator TOSSIM.		
UNIT V	**WSN APPLICATIONS AND CASE STUDIES**	**9**
WSN Applications - Medical Applications - Industrial Automation -Building Automation -Home Control - Nanoscopic Sensor Applications - Habitat Monitoring- Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation– Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking .		

	Total Hours: 45
	TEXTBOOKS
1.	Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2.	Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.
	REFERENCE BOOKS
1.	K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
2.	Philip Levis, " TinyOS Programming"
3.	Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd,
4.	Ian F. Akyildiz , Mehmet Can Vuran,Wireless Sensor Networks, Wiley India , 1, 2018. C. S. Raghavendra, K.M.Shivalingam and T.Znati, "Wireless Sensor Networks", Springer, New York, 2004
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basis of Sensors node and their characteristic.
CO2	Understand the design issues of various MAC protocols
CO3	Develop the concepts of design issues of different routing protocols of WSN
CO4	Understand different embedded operating system used in WSN
CO5	Explore and implement solutions to real world problems using sensor devices, enumerating its principles of working.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	1	1	-	-	-	-	1	3	2	2	1	1
CO2	3	3	2	2	1	1	-	-	-	-	1	3	3	2	1	1
CO3	3	3	3	3	2	2	-	-	-	-	1	3	3	2	1	1
CO4	3	3	2	3	3	2	-	-	-		2	3	2	2	2	1
CO5	3	3	3	3	3	3	-	-	-	-	3	3	3	3	2	2

EC4874	**INDUSTRIAL IOT AND INDUSTRY 4.0**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Learn and understand the Importance of IoT
- Know how IoT has become a game changer in the new economy.
- Apply the IoT concepts in building solutions to Industrial problems.
- Learn and understand the tools and techniques that enable IoT solution and Security aspects.
- IoT in industrial applications

UNIT I	**INTRODUCTION TO INDUSTRIAL IOT (IIOT) SYSTEM**	**9**
The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories		CO1

UNIT II	**IMPLEMENTATION SYSTEMS FOR IIOT**	**9**
Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems.		CO2
UNIT III	**IIOT DATA MONITORING & CONTROL**	**9**
IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology.		CO3
UNIT IV	**INDUSTRIAL IOT- APPLICATIONS**	**9**
Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.		CO4
UNIT V	**INTRODUCTION OF INDUSTRY 4.0**	**9**
Introduction to Smart Manufacturing, IoT applications in Manufacturing, Cloud applications in manufacturing. Introduction to Computer Aided Process Planning (CAPP), Algorithms for CAPP, CADCAM development, Industry 4.0 applications in Product Development		CO5
	Total Hours:	45

	TEXTBOOKS
1	SudipMisra, Chandran Roy, Anandarup Mukherjee: Introduction to Industry IOT and Industry 4.0 , CRC press, Taylor & Francis First Edition 2021.
	REFERENCE BOOKS
1.	HakimaChaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821- 140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi
2.	The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
3.	Industry 4.0: The Industrial Internet of Things Alasdair GilchristPublications: Apress
4.	Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers
	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the elements of IoT to build a total control plane in an Industrial application
CO2	Apply M2M protocols for development of IoT Applications.
CO3	Learn and understand the concept of digitalization and data acquisition.
CO4	Build smart factory based on the concepts
CO5	Learn about Industry 4.0 Needs and Updates

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3	
COs	**PROGRAMME OUTCOMES**	**PROGRAMME SPECIFIC OUTCOMES**

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	2	2	2	2	2	3	2	-	-	-	-	2	3	3	3	2
CO2	2	2	2	2	2	3	1	-	-	-	-	2	2	3	2	2
CO3	2	2	2	2	2	3	1	-	-	-	-	2	3	3	3	2
CO4	2	1	3	2	2	3	2	-	-	-	-	2	3	3	2	2
CO5	2	2	3	2	2	2	2	-	-	-	-	1	3	3	3	2

EC4875	**MEMS DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To study the various materials and their properties used for micromachining techniques.
- To analyze the fundamentals of micromachining and micro fabrication techniques.
- To impart knowledge of the basic concept of electromechanical effects, thermal effects Micro fluidics and Integrated fluidic systems.
- To study the fundamentals of pressure sensors and accelerometer sensors through design and modeling.

UNIT I	**ENGINEERING FOR MICROSYSTEMS DESIGN AND FABRICATION**	**9**
Working Principles of Microsystems-Materials for MEMS-Single crystal silicon-Polysilicon-Silicon Dioxide-Silicon Nitride-Germanium based materials-Metals-Silicon Carbide-Diamond-Wet-Bulk Micromachining-Silicon Crystallography-Silicon as substrate-Silicon as a mechanical element in MEMS-Silicon as a Sensor-Wet isotropic and Anisotropic Etching-Etching with bias-Surface Micromachining-Mechanical properties Thin films-Comparison of Bulk Micromachining and Surface Micromachining		CO1
UNIT II	**MEMS TRANSDUCERS**	**9**
Mechanical Transducers-Mechanical Sensors-Mechanical Actuators-Radiation Transducers-Radiation Sensors-Radiation (Optical) Actuators-Thermal Transducers-Thermal Sensors-ThermalActuators- Magnetic Transducers-Magnetic Sensors-Magnetic Actuators-Chemical and Biological Transducers- Chemical and Biological Sensors-Chemical Actuators-Microfluidic Devices.		CO2
UNIT III	**SYSTEM-LEVEL MEMS DESIGN**	**9**
Introduction- Fundamentals of System-Level Modeling and Memsic Co-Simulation-Methodology I: Lumped-Element Modeling with Equivalent Circuits- Methodology II: Hierarchical Abstraction Of Mems And Analytical Behavioral Modeling- Methodology III: Mems Behavioral Modeling Based on FEA/BEA- CAD for Integrated MEMS Design.		CO3
UNIT IV	**FABRICATION OF MEMS**	**9**
Micro-Opto-Electromechanical systems: Introduction, fundamental principle of MOEMs Technology, Review on properties of light, Light Modulators, beam Splitters, Microlense, Micro mirrors, digital micromirror device, light detectors, grating light valve, optical switch, waveguideand tuning, shear Stress measurement, Magnetic Sensors and actuators.		CO4
UNIT V	**APPLICATIONS OF MEMS-SWITCHING**	**9**
Introduction, Switch parameters, Basics of switching, Mechanical switches, Electronic switches for RF and microwave applications, Mechanical RF switches, PIN diode RF switches.		CO5

Total Hours:	45

	TEXTBOOKS
1.	MEMS and Micro Systems design and Manufacture, Tai-ran HSU, TMH, 2006.
2.	MEMS, Nitaigour Premchand Mahalik, TMH
	REFERENCE BOOKS
1.	Mohammedhad-el-hak, MEMS Introduction & Fundamentals, CRC Press, 2005
2.	Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, 3rd Edition, 2011, CRC Press. ISBN 9780849331800

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basic overview of MEMS and Microsystems with broad category of MEMS & Micro system applications.
CO2	Understanding the working principles of Microsystems
CO3	Understand the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
CO4	Understand the Micro system Fabrication Process and Analyze the different Micro manufacturing process and Applications.
CO5	Study and Analyze the different types of RF switches, Various Switching Mechanism and their applications.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO 2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	1	3	2	2	-	2	-	-	1	2	2	2	2
CO2	3	2	1	1	2	2	2	-	2	-	-	1	3	2	2	2
CO3	3	3	2	2	3	2	2	-	2	-	-	1	3	2	2	2
CO4	3	3	2	3	3	2	2	-	2	-	-	1	3	2	2	2
CO5	3	3	3	3	3	1	2	-	2	-	-	1	3	2	3	2

EC4876	**FUNDAMENTALS OF NANO ELECTRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To understand the concepts of nano electronics and quantum electronics.
- To understand the concepts of nano electronic devices, transistors, tunneling devices and superconducting devices.
- To understand the basics of nanotube devices.

UNIT I	**ELECTRONICS TO NANO ELECTRONICS**	**9**

Scaling to nano - Light as a wave and particle- Electrons as waves and particles- origin of quantum mechanics - General postulates of quantum mechanics - Time independent Schrodinger wave equation- Electron confinement - Quantum dots, wires and well-Spin and angular momentum- Wave packets and uncertainty.		
UNIT II	**QUANTUM ELECTRONIC DEVICES**	**9**
Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor - Electron wave transistor - Electron spin transistor - Quantum cellular automata - Quantum dot array, Quantum memory.		
UNIT III	**NANO ELECTRONIC TRANSISTORS**	**9**
Coulomb blockade - Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions - Single electron transistors, Semiconductor nanowire FETs and SETs, Molecular SETs and molecular electronics - Memory cell.		
UNIT IV	**NANOELECTRONIC TUNNELING AND SUPER CONDUCTING DEVICES**	**9**
Tunnel effect -Tunneling element -Tunneling diode - Resonant tunneling diode - Three terminal resonant tunneling devices- Superconducting switching devices- Cryotron- Josephson tunneling device.		
UNIT V	**NANOTUBES AND NANOSTRUCTURE DEVICES**	**9**
Carbon Nanotube - Fullerenes - Types of nanotubes – Formation of nanotubes –Assemblies – Purification of carbon nanotubes – Electronic properties – Synthesis of carbon nanotubes – Carbon nanotube interconnects – Carbon nanotube FETs and SETs –Nanotube for memory applications- Nano structures and nano structured devices.		
	Total Hours:	45

	TEXTBOOKS
1.	Hanson, Fundamentals of Nanoelectronics, Pearson education, 2009.
2.	Jan Dienstuhl, Karl Goser, and Peter Glösekötter, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer-Verlag, 2004.
	REFERENCE BOOKS
1	Mircea Dragoman and Daniela Dragoman, Nanoelectronics: Principles and Devices, Artech
2	House, 2009.
3	Robert Puers, Livio Baldi, Marcel Van de Voorde and Sebastiaan E. Van Nooten, Nanoelectronics: Materials, Devices, Applications, Wiley, 2017.
4	Brajesh Kumar Kaushik, Nanoelectronics: Devices, Circuits and Systems, Elsevier science, 2018.
	Murty B S, Shankar P, Baldev Raj, Rath B B and James Murday, Textbook of Nanoscience and Nanotechnology, Springer, Universities press, 2012 .

	COURSE OUTCOMES: After completing this course, the students will be able to
CO1	Understand the basics of nano electronics including quantum wires, dots, and wells.
CO2	Use the mechanism behind quantum electronic devices.
CO3	Analyze the nano electronic transistors
CO4	Analyze the key performance aspects of tunneling and superconducting nano electronic devices.
CO5	Apply the knowledge in the development of nanotubes and nanostructure devices.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	3	3	3	3	3	2	-	-	-	-	-	1	2	1	1	1
CO2	3	3	3	2	3	2	-	-	-	-	-	1	2	1	1	1
CO3	3	3	2	2	2	1	-	-	-	-	-	1	2	2	1	1
CO4	3	3	2	2	2	1	-	-	-	-	-	1	2	1	2	1
CO5	3	3	3	3	2	1	-	-	-	-	-	1	2	1	2	1

OPEN ELECTIVE I

OMA411	GRAPH THEORY AND ITS APPLICATIONS	L	T	P	C
	(Common to CSE, ECE, CSE, MECH, IT & ADS)	3	0	0	3

OBJECTIVES:

- To introduce the basic notions of graphs and trees which will then be used to solve related problems.
- To introduce and apply the concepts of trees, connectivity and planarity.
- To understand the basic concepts of colouring in graph theory.
- To understand the basic concepts of permutations and combinations.
- To acquaint the knowledge of recurrence relations and generating function.

UNIT I	INTRODUCTION OF GRAPHS	9
Graphs – Introduction – Isomorphism – Sub graphs – Walks, Paths, Circuits –Connectedness – Components – Euler graphs – Hamiltonian paths and circuits – Trees – Properties of trees – Distance and centers in tree – Rooted and binary trees.		CO1
UNIT II	**TREES, CONNECTIVITY AND PLANARITY**	**9**
Spanning trees – Fundamental circuits – Spanning trees in a weighted graph – cut sets – Properties of cut set – All cut sets – Fundamental circuits and cut sets – Connectivity and separability – Network flows – 1-Isomorphism – 2-Isomorphism – Combinational and geometric graphs – Planer graphs – Different representation of a planer graph.		CO2
UNIT III	**MATRICES, COLOURING AND DIRECTED GRAPH**	**9**
Chromatic number – Chromatic partitioning – Chromatic polynomial – Matching – Covering – Four color problem – Directed graphs – Types of directed graphs – Digraphs and binary relations – Directed paths and connectedness – Euler graphs.		CO3
UNIT IV	**PERMUTATIONS AND COMBINATIONS**	**9**
Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.		CO4
UNIT V	**GENERATING FUNCTIONS**	**9**
Generating functions - Partitions of integers - Exponential generating function – Summation operator - Recurrence relations - First order and second order – Non-homogeneous recurrence relations - Method of generating functions.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Narsingh Deo, “Graph Theory: With Application to Engineering and Computer Science”, Prentice Hall of India, 2003.
2.	Grimaldi R.P. “Discrete and Combinatorial Mathematics: An Applied Introduction”, Addison Wesley, 1994.
	REFERENCE BOOKS
1.	Clark J. and Holton D.A, “A First Look at Graph Theory”, Allied Publishers, 1995.
2.	Mott J.L., Kandel A. and Baker T.P. “Discrete Mathematics for Computer Scientists and Mathematicians”, Prentice Hall of India, 1996.
3.	Liu C.L., “Elements of Discrete Mathematics”, Mc Graw Hill, 1985.
4.	Rosen K.H., “Discrete Mathematics and Its Applications”, Mc Graw Hill, 2007.
	COURSE OUTCOMES: Upon completion of the course, students will be able to
CO1	Write precise and accurate mathematical definitions of objects in graph theory.

CO2	Use mathematical definitions to identify and construct examples and to distinguish examples from non-examples.
CO3	Validate and critically assess a mathematical proof.
CO4	Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory.
CO5	Reason from definitions to construct mathematical proofs.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFIC OUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	1	1	1	2	1	1	1	-	-	-	1	0
CO2	3	3	2	1	1	1	-	2	1	1	-	1	-	-	1	1
CO3	2	3	2	1	2	1	-	1	2	2	-	-	-	-	1	1
CO4	3	2	2	2	1	1	-	2	1	1	1	1	-	-	1	1
CO5	3	3	2	1	1	1	1	1	2	1	1	-	-	-	1	1

OEE411	**RENEWABLE ENERGY SYSTEMS**	**L**	**T**	**P**	**C**
Common to CSE, ECE, CSE, MECH, IT & ADS)		**3**	**0**	**0**	**3**

OBJECTIVES:

- To create awareness about renewable and non-renewable Energy Sources, technologies and its impact on the environment
- To learn wind energy conversion system and its issues with grid integration.
- To learn the concepts of solar PV and solar thermal systems.
- To learn other alternate energy sources such as Biomass, geothermal energy and hydro energy variety of issues in harnessing
- To understand the concept of tidal energy, hydrogen energy, ocean thermal energy and its significance.

UNIT I	**RENEWABLE ENERGY SOURCES**	**9**
Conventional energy sources- Fossil Fuels, Types of fossil fuel, Environmental consequences of fossil fuel use, Non-Conventional energy sources- Renewable energy(RE) and its types, Significances of renewable energy sources, Sustainable Design and development, Effects and Limitations of RE sources.		CO1
UNIT II	**WIND ENERGY**	**9**
Wind formation, Power in the Wind – WPP (wind power plant)- Components of WPPs -Types of Wind Power Plants (WPPs)– Working of WPPs- Siting of WPPs-Grid integration issues of WPPs.		CO2
UNIT III	**SOLAR - THERMAL SYSTEMS AND PV SYSTEMS**	**9**
Solar Radiation, Radiation Measurement, Solar Thermal system and its types, Solar Photovoltaic systems (SPV) : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections - Applications.		CO3
UNIT IV	**BIOMASS, GEOTHERMAL AND HYDRO ENERGY SOURCES**	**9**
Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal		CO4

Electricity. Mini/micro hydro power: Classification of hydropower schemes, Essential components of hydroelectric system.		
UNIT V	**OTHER ENERGY SOURCES**	**9**
Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications.		CO5
	Total Hours:	**45**
	TEXTBOOKS	
1.	Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, 2015.	
2.	D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.	
3.	Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.	
	REFERENCE BOOKS	
1.	A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011	
2.	Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015	
3.	Chetan Singh Solanki, "Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011	
4.	Bradley A. Striebig, AdebayoA.Ogundipe and Maria Papadakis," Engineering Applications in Sustainable Design and Development", Cengage Learning India Private Limited, Delhi, 2016.	
5.	Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.	
6.	Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education ,2015.	
7.	NPTEL Video Lecture Notes on "Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems" by Prof. Vaibhav Vasant Goud, Prof. R. Anandalakshmi, IIT Guwahati.	
	COURSE OUTCOMES: Upon completion of the course, students will be able to	
CO1	Ability to create awareness about non- renewable and renewable Energy Sources and technologies	
CO2	Acquire knowledge on the concepts of wind energy conversion system, siting and grid related issues.	
CO3	Ability to understand the solar PV and solar thermal systems	
CO4	Ability to analyse other types of renewable energy resources like biomass, geothermal and Hydro energy.	
CO5	Ability to Acquire knowledge on tidal energy, hydrogen energy, ocean thermal energy and fuel cell.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	1	1	1	1	3	3	3	1	1	1	3	-	-	2	1
CO2	3	3	3	3	3	3	3	3	3	1	3	3	-	-	2	1
CO3	3	3	3	3	3	3	3	3	3	1	3	3	-	-	2	1
CO4	3	3	3	3	3	3	2	3	3	1	2	3	-	-	2	1
CO5	3	3	3	3	3	3	2	3	3	1	2	3	-	-	2	1

OEC412	**FOUNDATIONS OF ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To comprehend how a robot's fundamental parts work.
- To examine how different Ends of Effectors and sensors are used.
- To disseminate information on programming and robot kinematics.
- To learn about the economics, safety, and future of robots.

UNIT I	**FUNDAMENTALS OF ROBOT**	**9**
Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types, and Classification – Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions - Need for Robots - Different Applications.		CO1
UNIT II	**SYSTEMS FOR ROBOT DRIVE AND END EFFECTORS**	**9**
Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives - End effectors - Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position, and velocity feedback devices - Robot joints and links - Types, Motion interpolation.		CO2
UNIT III	**SENSORS AND MACHINE VISION**	**9**
Sensors in robots: Touch Sensors, Tactile Sensors, Proximity, and range sensors, Force sensor, Light sensors, Pressure sensors - Triangulations Principles Structured - Lighting Approach, Time of Flight, Camera, Frame Grabber, Sensing and Digitizing Image Data - Signal Conversion, Image Storage, Lighting Techniques, Image Processing, and Analysis - Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications Inspection, Identification, Visual Serving, and Navigation.		CO3
UNIT IV	**KINEMATICS AND PROGRAMMING FOR ROBOTS**	**9**
Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point-to-point, Continuous Path Control, Robot programming - Introduction to Artificial Intelligence.		CO4
UNIT V	**ROBOT APPLICATIONS AND ECONOMIC IMPLEMENTATION**	**9**
RGV, AGV, Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, and Disaster management. Applications, Micro and Nanorobots, Future Applications. - Robotics adoption in Industries - Safety Considerations for Robot Operations - Economic Analysis of Robots.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Klafter R.D., Chmielewski T.A, and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.

2.	Bruno Siciliano, Oussama Khatib, “Springer Handbook of Robotics”, Springer, 2008.
	REFERENCE BOOKS
1. 2. 3. 4.	Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata –McGraw Hill Pub. Co., 2008. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
	COURSE OUTCOMES: Upon completion of the course, students will be able to
CO1	List and describe the fundamental components of industrial robots.
CO2	Examine the kinematics and control strategies of the robot.
CO3	To improve performance, classify the numerous robot sensors.
CO4	To list the different commercial and noncommercial uses of robots.
CO5	Able to apply basic engineering knowledge for the design of robotics

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	3	2	2	2	-	-	-	-	2	3	3	2	1	2
CO2	3	3	3	3	2	3	-	-	-	-	2	2	3	2	1	2
CO3	3	2	3	3	2	2	-	-	-	-	2	3	3	2	1	2
CO4	3	3	3	2	2	2	-	-	-	-	2	2	3	2	2	2
CO5	2	2	3	3	2	3	-	-	-	-	2	3	3	2	2	2

OMB413	**DIGITAL MARKETING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
OBJECTIVES: • The primary objective of this module is to examine and explore the role and importance of digital marketing in today’s rapidly changing business environment. • It also focusses on how digital marketing can be utilised by organisations and how its effectiveness can be measured.					
UNIT I	**INTRODUCTION TO DIGITAL MARKETING**				**9**
Online Market space- Digital Marketing Strategy- Components -Opportunities for building Brand- Website - Planning and Creation- Content Marketing.					CO1
UNIT II	**SEARCH ENGINE OPTIMISATION**				**9**
Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off-Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising -Display Advertisement.					CO2
UNIT III	**E-MAIL MARKETING**				**9**
E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation – Integrating Email with Social Media and Mobile- Measuring and maximising email campaign					CO3

effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting.		
UNIT IV	**SOCIAL MEDIA MARKETING STRATEGIES**	**9**
Social Media Marketing - Social Media Channels- Leveraging social media for brand conversations and buzz. Successful/benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.		CO4
UNIT V	**BRAND PERFORMANCE**	**9**
Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Fundamentals of Digital Marketing by Puneet Singh Bhatia; Publisher: Pearson Education; First edition (July 2017).
2.	Digital Marketing by Vandana Ahuja ;Publisher: Oxford University Press (April 2015)
	REFERENCE BOOKS
1.	Marketing 4.0: Moving from Traditional to Digital by Philip Kotler; Publisher: Wiley; 1st edition (April 2017);
2.	Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited.
3.	Pulizzi, J Beginner's Guide to Digital Marketing , Mcgraw Hill Education.
4.	Barker, Barker, Bormann and Neher(2017), Social Media Marketing: A Strategic Approach, 2E South-Western, Cengage Learning.
	COURSE OUTCOMES: Upon completion of the course, students will be able to
CO1	To examine and explore the role and importance of digital marketing in today's rapidly changing business environment.
CO2	To focusses on how digital marketing can be utilised by organisations and how its effectiveness can measured.
CO3	To know the key elements of a digital marketing strategy
CO4	To study how the effectiveness of a digital marketing campaign can be measured
CO5	To demonstrate advanced practical skills in common digital marketing tools such as SEO, SEM, Social media and Blogs.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2	2	1	3	3	1	1	2	1	3	1	-	-	2	1
CO2	3	3	2	1	3	1	1	2	1	1	1	1	-	-	2	1
CO3	3	3	3	2	1	1	2	1	3	1	1	2	-	-	2	1
CO4	3	3	2	2	3	3	2	1	1	1	3	2	-	-	2	1
CO5	3	2	2	1	2	2	2	3	1	1	2	2	-	-	2	1

OAD414	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
(Common to Electronics and Communication Engineering)		3	0	0	3

OBJECTIVES:

- To provide a strong foundation on fundamental concepts in Artificial Intelligence.
- To enable Problem-solving through various searching techniques.
- Introduce Machine Learning and supervised learning algorithms
- Study about ensembling and unsupervised learning algorithms
- To apply Artificial Intelligence techniques primarily for machine learning.

UNIT I	INTRODUCTION TO AI AND SEARCHING	9
Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies: A* algorithm – Game Playing: Alpha Beta Pruning – constraint satisfaction problems (CSP)		CO1
UNIT II	**UNIT II KNOWLEDGE REPRESENTATION**	**9**
Knowledge-based agents – propositional logic – propositional theorem proving – propositional model checking – agents based on propositional logic. First-order logic – forward chaining – backward chaining – resolution.		CO2
UNIT III	**SUPERVISED LEARNING**	**9**
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier		
UNIT IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9**
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization		
UNIT V	**INTELLIGENCE AND APPLICATIONS**	**9**
Natural language processing-Morphological Analysis-Syntax analysis -Semantic Analysis-Ail applications – Language Models - Information Retrieval – Information Extraction – Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.
2.	Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Third Edition, Tata McGraw-Hill, 2010.
	REFERENCE BOOKS
1.	Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Pearson Education,2007
2.	Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3.	Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
	COURSE OUTCOMES: Upon completion of the course, students will be able to
CO1	Use appropriate search algorithms for problem solving
CO2	Provide a basic exposition to the goals and methods of Artificial Intelligence.

CO3	Build supervised learning models
CO4	Build ensembling and unsupervised models
CO5	Improve problem solving skills using the acquired knowledge in the areas of natural language processing with machine learning.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	1	1	1	1	1	1	1	1	2	-	-	2	1
CO2	3	3	2	2	1	1	1	1	1	1	1	2	-	-	2	1
CO3	3	3	2	2	3	1	1	1	1	1	1	2	-	-	2	1
CO4	3	3	2	2	1	1	1	1	1	1	1	2	-	-	2	1
CO5	3	3	2	2	2	1	1	1	1	1	1	3	-	-	2	1

OMA426	**RESOURCE MANAGEMENT TECHNIQUES**	**L**	**T**	**P**	**C**
	(Common to all B.E. / B. Tech.)	**3**	**0**	**0**	**3**

OBJECTIVES:

- Be familiar with resource management techniques.
- Learn to solve problems in linear programming and Integer programming.
- To understand the concept of non-linear programming.
- Be exposed to CPM and PERT.

UNIT I	**LINEAR PROGRAMMING**	**9**
Principal components of decision problem – Modeling phases – LP Formulation and graphic solution – Resource allocation problems – Simplex method – Sensitivity analysis.		CO1
UNIT II	**DUALITY AND NETWORKS**	**9**
Definition of dual problem – Primal – Dual relationships – Dual simplex methods – Post optimality analysis – Transportation and Assignment model - Shortest route problem.		CO2
UNIT III	**INTEGER PROGRAMMING**	**9**
Cutting plan algorithm – Branch and Bound methods, Multistage (Dynamic) Programming.		CO3
UNIT IV	**CLASSICAL OPTIMISATION THEORY**	**9**
Unconstrained external problems, Newton – Raphson method – Equality constraints – Jacobian methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.		CO4
UNIT V	**OBJECT SCHEDULING**	**9**
Network diagram representation – Critical path method – Time charts and resource leveling – PERT		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	H.A. Taha “Operation Research”, Prentice Hall of India, 2002.
2.	Paneer Selvam “Operations Research”, Prentice Hall of India, 2002
	REFERENCE BOOKS
1.	Anderson “Quantitative Methods for Business”, 8th Edition, Thomson Learning, 2002.
2.	Winston “Operation Research”, Thomson Learning, 2003.
3.	Vohra “Quantitative Techniques in Management”, Tata Mc Graw Hill, 2002.
4.	Anand Sarma “Operation Research”, Himalaya Publishing House, 2003

	COURSE OUTCOMES: Upon completion of the course, students will be able to
CO1	Solve optimization problems using simplex method.
CO2	Solve optimization problems using Duality concept, solve Transportation and assignment models.
CO3	Apply integer programming and linear programming to solve real-life applications.
CO4	Solving Unconstrained external problems.
CO5	Use PERT and CPM for problems in project management.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	2	2	1	-	-	-	1	1	1	-	-	-	1	2
CO2	2	2	2	1	1	-	-	-	1	1	-	1	-	-	1	2
CO3	2	3	2	1	1	-	-	-	2	2	-	-	-	-	1	2
CO4	2	2	2	2	1	-	-	-	1	1	1	1	-	-	1	2
CO5	2	1	2	1	1	-	-	-	2	1	1	-	-	-	1	2

OME417/ EC4525	**INTRODUCTION TO INDUSTRIAL ENGINEERING**	**L**	**T**	**P**	**C**
Common to ECE, CSE, IT & ADS		**3**	**0**	**0**	**3**

OBJECTIVES:

- To provide the knowledge on Forecasting methods and planning procedure.
- To expose the students to the basics in Inventory and Quality Control.
- To provide the knowledge on various Economic Evaluation techniques.

UNIT I	**FORECASTING AND AGGREGATE PLANNING**	**9**
Defining Operations Management, functions and its historical evolution. Forecasting: Approaches to Forecasting: Qualitative approach - Judgmental methods, quantitative methods- time series, regression. Aggregate Planning: purpose, procedure and techniques		CO1
UNIT II	**PRODUCTION MANAGEMENT & SCHEDULING**	**9**
Production Management: Types of production systems, Product analysis, brief treatment of functions of production Planning and Control, Value analysis Scheduling: Introduction, concept of batch production systems, Loading, Sequencing, and Scheduling the n jobs on a single machine, two machines, three machines, m-machines. Problem solving.		CO2
UNIT III	**INVENTORY AND QUALITY CONTROL**	**9**
Inventory Control : Introduction, models, Inventory costs, Basic models EOQ and EBQ with-out shortages, Quantity discounts, Selective control -- ABC analysis, Problem solving Quality		CO3

Control : Inspection and types, SQC - Control charts for attributes and variables, construction and application – Acceptance sampling, sampling plans, Construction of O.C. curve. Problem solving.		
UNIT IV	**GENERAL AND PERSONNEL MANAGEMENT**	**9**
General Management: General Management, Principles of Scientific Management; Brief treatment of Managerial Functions. Modern Management concept. Personnel Management: The Personnel Function, Staff Role in Person Department, Personnel Functions, Job Design, Job Information.		CO4
UNIT V	**ECONOMIC EVALUATION**	**9**
Financial Management: Concept of Interest, Compound Interest, Economic Evaluation of Alternatives: The Annual Equivalent Method, Present Worth Method, Future Worth Method Depreciation – Purpose, Types of Depreciation; Common Methods of Depreciation; The Straight-Line Method, Declining Balance Method, The Sum of the years Digits Method, A Brief Treatment of Balance Sheet, Ratio Analysis. Introduction to JIT / Lean Manufacturing, Six Sigma Quality Concept, Supply Chain Management, Business Process Reengineering, Concurrent Engineering, Enterprise Resource Planning.		CO5
	Total Hours:	**45**
	TEXTBOOKS	
1.	O.P.Khanna, Industrial Engineering and Management, 7th Edition, DhanpatRai& Sons, 2002.	
2.	Mortand Telsang, Production and Operating Management, 2nd Edition, S.Chand,2006.	
	REFERENCE BOOKS	
1.	E.S.Buffa, Modern Production/Operation Management, 8th Edition, Wiley India, 2007.	
2.	Joseph G Monks, Operation Management, 3rd Edition, Tata McGraw Hill, 1987.	
	COURSE OUTCOMES: Upon completion of the course, students will be able to	
CO1	Understand the Forecasting methods and planning procedure.	
CO2	Explain the concepts of general management, financial management, human resources, production management, and marketing management.	
CO3	Illustrate the application with to identify solutions to industry problems	
CO4	Implement the Principles of Scientific and personnel Management	
CO5	Identify the optimum solutions with system approach to both industry and service sector.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	-	-	-	-	-	1	2	2	1	3	-	-	-	1	1
CO2	3	3	-	-	-	-	1	2	2	1	3	-	-	-	1	1
CO3	3	3	-	-	-	-	1	2	2	1	3	-	-	-	1	2
CO4	3	3	-	-	-	-	1	2	2	1	3	-	-	-	1	2
CO5	3	3	-	-	-	-	1	2	2	1	3	-	-	-	1	2

OPEN ELECTIVE II

OEE421	ELECTRIC AND HYBRID VEHICLE	L	T	P	C
	(Common to CSE, ECE, MECH, IT& ADS)	3	0	0	3

OBJECTIVES:

- To provide knowledge of the operation and dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of electrical vehicles (EVs)
- To estimate the energy requirement of EVs and Hybrid Electric Vehicles (HEVs)
- To provide knowledge about different energy sources and energy management in HEVs.
- To provide knowledge of supervisory control of EVs

UNIT I	INTRODUCTION TO CONVENTIONAL AND ELECTRIC VEHICLES	9
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics. **Electric Vehicle:** EV system- Series parallel architecture of Hybrid Electric Vehicles (HEV) - Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.		**CO1**
UNIT II	**MECHANICS OF ELECTRIC VEHICLES**	**9**
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of EV's - motor torque and power rating and battery capacity.		**CO2**
UNIT III	**CONTROL OF DC AND AC MOTOR DRIVES**	**9**
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Construction and operation of PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives.		**CO3**
UNIT IV	**ENERGY STORAGE AND MANAGEMENT SYSTEMS**	**9**
Battery: Principle of operation, types, models, Estimation of SOC & SOH, Traction Batteries and their capacity for standard drive cycles. **Alternate sources:** Fuel cells, Ultra capacitors, Fly wheels.		**CO4**
UNIT - V	**HYBRID VEHICLE CONTROL STRATEGY**	**9**
HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode.		**CO5**
	Total Hours:	**45**

Text Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. Iqbal Husain, "Electric and Hybrid vehicles: Design fundamentals", CRC PRESS, Boca Raton London, New York Washington, D.C,2005.

Reference Books:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. Larminie, James and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
4. Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017.
5. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.
6. Gregory L. Plett, "Battery Management systems", ARTECH House,London,2016.
7. NPTEL Video Lecture Notes on "Fundamentals of Electric Vehicles: Technology and

	Economics" by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan, IIT Madras.
Course Outcomes (CO)	
CO1	Learned the significance of Electric Vehicle compared to conventional vehicles.
CO2	Understood the concept of mechanics of Electric Vehicles.
CO3	Acquired the knowledge in control of DC And AC motor drives.
CO4	Concepts related to battery technology and energy storage systems are analysed.
CO5	Acquired knowledge in control strategy for Hybrid Vehicle & Battery management systems for EV

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2	3	1	3	2	2	3	3	2	1	3	-	-	**2**	1
CO2	3	2	3	3	3	2	2	3	3	2	1	2	-	-	**2**	1
CO3	3	3	3	3	2	2	2	3	2	2	2	3	-	-	**2**	1
CO4	3	2	3	3	3	3	3	3	3	3	2	3	-	-	**2**	1
CO5	3	2	2	2	3	3	3	3	3	3	2	3	-	-	**2**	1

AD4513	**DEVELOPMENTS AND OPERATIONS (Dev-Ops)**	**L**	**T**	**P**	**C**
	(Common to CSE, IT and ADS)	3	0	0	3

COURSE OBJECTIVES

- To understand Dev-Ops fundamentals.
- To understand the tangible and real benefits of DevOps.
- To understand DevOps culture.
- To understand Infrastructure Automation, Continuous Delivery, & Reliability Engineering concepts.
- To understand the Practices and tools used in DevOps.
- To understand DevOps emerging areas including DevOps security.

UNIT I	**FUNDAMENTALS**	**9**
DevOps: Definition, Values, Principles, Methodologies, Practices, Tools, Communication, Wall of confusion, Communication, Collaboration, Transition, Continuous improvement (Kaizen), Linux Commands.		**CO1**
UNIT II	**BUILDING BLOCKS**	**9**
Communication and Collaboration, Continuous improvement, Automation and testing, Lean & Agile - Methodologies, Implementations, Build, Measure, Learn ITIL, ITSM, SDLC		**CO2**
UNIT III	**INFRASTRUCTURE AUTOMATION**	**9**
Source control, Build and release management, Configuration management, Continuous integration and delivery, Monitoring and logging		**CO3**
UNIT IV	**CONTINUOUS DELIVERY**	**9**
CI practices, CD pipeline, QA, CI tools, Securing CI/CD pipeline - DevSecOps, Development tools, inherit tools, Build tools, Deploy tools, Operation tools, Orchestration.		**CO4**
UNIT V	**RELIABILITY ENGINEERING**	**9**
SRE basics, Practice - Release Engineering, Change Management, Fault tolerance and resilience, SLAs, Troubleshooting, Performance Engineering: Testing and validation, Scalability, Organization, Emerging areas: Cloud, Containers, Server-less, Security, Load balancing.		**CO5**

	Total Hours:	**45**
	TEXTBOOKS	
1.	Gene Kim, Kevin Behr, George Spafford, "The Phoenix Project - a Novel IT, DevOps,and helping your Business Win", 2018	
	REFERENCE BOOKS	
1.	Gary Gruver, Tommy Mouser, Leading the Transformation - Applying Agile and DevOps principles at scale, IT Revolution, Portland.	
2.	Gene Kim, Jez Humble, Patrick Debois, John Willis, The DevOps Handbook - How to create world-class agility, reliability, and security in technology organizations".	
3.	Kenin, Gene, George, The Visible OPS Handbook - Implementing ITIL in 4 practical and auditable steps".	
4.	Jez Humble, David Farley, Continuous Delivery, Addison –Wesley Signature series.	
5.	Jennifer Davis & Katherine Daniels, Effective DevOps - Building a culture of collaboration, affinity, and tooling at scale.	
6.	Mary Poppendieck & Tom Poppendieck, Lean Software Development - An Agile Toolkit.	
7.	John Allspaw, Web Operations - Keeping the Data on Time.	
8.	Thomas, The Practice of cloud system administration - Designing and operating large distributed systems	
	COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Explain the core concepts/principles of DevOps.	
CO2	Experiment DevOps concepts by using various tools.	
CO3	Outline the benefits of DevOps	
CO4	Implement security across the entirety of the continuous integration and continuous delivery (CI/CD)	
CO5	Create scalable and highly reliable software systems	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	2	2	1	1	-	-	-	1	1	2	-	-	1	1
CO2	3	3	2	2	1	1	-	-	-	1	1	2	-	-	1	1
CO3	3	3	2	2	1	1	-	-	-	1	1	2	-	-	1	1
CO4	3	3	2	2	1	1	-	-	-	-	1	2	-	-	1	2
CO5	3	3	2	2	1	1	-	-	-	-	1	2	-	-	1	1

OEE423	**ADVANCED CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
		3	0	0	3

COURSE OBJECTIVES

To impart knowledge on the following topics:

- To provide knowledge on design state feedback control and state observer.
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter

UNIT – I	**STATE VARIABLE ANALYSIS**	**9**

Introduction- concepts of state variables and state model-State model for linear continuous time systems, Diagonalisation- solution of state equations- Concepts of controllability and observability.		**CO1**
UNIT – II	**STATE VARIABLE DESIGN**	**9**
Introduction to state model: Effect of state feedback - Pole placement design: Necessary and sufficient condition for arbitrary pole placement, State regulator design, Design of state observers- Separation principle- Design of servo systems: State feedback with integral control.		**CO2**
UNIT– III	**SAMPLED DATA ANALYSIS**	**9**
Introduction spectrum analysis of sampling process signal reconstruction difference equations The Z transform function, the inverse Z transform function, response of Linear discrete system, the Z transform analysis of sampled data control systems, response between sampling instants, the Z and S domain relationship. Stability analysis and compensation techniques.		**CO3**
UNIT IV	**NON LINEAR SYSTEMS**	**9**
Introduction - common physical non linearities, The phase plane method: concepts, singular points, stability of nonlinear systems, construction of phase trajectories system analysis by phase plane method. The describing function method, stability analysis by describing function method, Jump resonance.		**CO4**
UNIT V	**OPTIMAL CONTROL**	**9**
Introduction: Classical control and optimization, formulation of optimal control problem, Typical optimal control performance measures - Optimal state regulator design: Lyapunov equation, Matrix Riccati equation - LQR steady state optimal control – Application examples.		**CO5**
	Total Hours:	**45**
	TEXTBOOKS	
1.	M. Gopal, "Digital Control and State Variable Methods", 4th edition, McGraw Hill India, 2012	
2.	K. Ogata, 'Modern Control Engineering', 5th Edition, Pearson, 2012.	
	REFERENCE BOOKS	
1.	M. Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.	
2.	William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011.	
3.	Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.	
4.	T. Glad and L. Ljung,, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.	
5.	D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press,2009.	
6.	K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers,2006.	
7.	NPTEL Video Lecture Notes on "Advanced Control Systems" by Prof. S. Majhi, IIT Guwahati.	
8.	M. Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.	
	COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Able to understand the modelling of state equation and its solution.	
CO2	Able to understand the state model, observer and feedback system.	
CO3	Able to understand the sampled data analysis, various transforms, stability and compensation techniques.	
CO4	Able to understand the nonlinear systems and various methods of analysis.	

CO5	Able to understand and design optimal controller.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	1	1	1	1	1	1	1	2	1	1	-	-	1	1
CO2	3	2	1	1	1	1	1	1	1	2	1	2	-	-	1	1
CO3	2	2	1	1	1	1	1	1	1	1	1	2	-	-	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	2	-	-	1	1
CO5	2	2	1	1	1	1	1	1	1	1	1	2	-	-	1	1

OMB443	**FINTECH TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	0	0	3

COURSE OBJECTIVES

- To provide a broad introduction to the field of FinTech and Blockchain and its application in the field of Financial sector.
- To get a thorough knowledge on topics related block chain and crypto currencies, decentralized applications, innovative wealth management markets for smart contracts, applications of Blockchain technologies in various finance areas, alternative and P2P lending and crowd funding,

UNIT I	**FINTECH IN FINANCIAL SERVICES**	**9**
FinTech, Future prospects and potential issues with FinTech- Global FinTech investments-Digital banking-Impact of digital technology on banking sector- Changes in customer buying behaviour-New age payments and remittances-Social media based remittances-Digital mortgages-Global Financial Instruments, Asset Management and Capital Markets		**CO1**
UNIT II	**DIGITAL PAYMENTS**	**9**
New Generation Commerce-Point of sale evolution (POS)- m-POS business model-m- Wallets-Smart credit cards-T-commerce- Crowd funding and Crowd investing-P2P lending- Robo advising-FinTech and Global economy-New operating models for banks-Banking as service and Open APIs-Neo banks-Challenger banks		**CO2**
UNIT III	**FINTECH ANALYTICS**	**9**
Big data in the Financial services Industry-Internet of Things (IOT) - IOT in Financial services-Innovative wealth management-Personal Finance Management-InsurTech-P2P insurance Block chained insurance-Risk associated with crypto market-Cost associated with crypto market investment-Crypto currency wallets.		**CO3**
UNIT IV	**BLOCH CHAIN TECHNOLOGY**	**9**
Blockchain-Components of Blockchain -Public and private keys-Crypto currencies-Distributed ledgers- Impact of Blockchain in Financial Services—Applications of Blockchain in Financial Services-Clearing and Settlement- Trade Finance-Compliances-Know Your Customer-Anti Money Laundering.		**CO4**
UNIT V	**INFORMATION SECURITIES IN FINTECH**	**9**
Distributed ledger for identification-Identification for Unbanked-Unique identification system in India-Using biometrics as Identification Cybercrime-Cyber security categories and players-Reg Tech		**CO5**
	Total Hours:	**45**

	TEXTBOOKS
1.	Blockchain Application in Finance, Peter Borovykh, Blockchain Driven, 2nd Edition, 2018
2.	FinTech in a Flash, Financial Technology Made Easy, Agustin Rubini, Banking Innovations 2nd edition 2017
	REFERENCE BOOKS
1.	Inclusive FinTech: Blockchain, Cryptocurrency and ICO, David Lee Chuen and Linda Low, World Scientific Publishing, 2018
2.	Susanne Chishti and Janos Barberies : The Fintech Book : The Financial technology Handbook for investors, entrepreneurs and visionaries 1st edition. Kindle edition. Wiley (2016)

	COURSE OUTCOMES Upon completion of the course, students will be able to
CO1	Ability to apply the concepts of FinTech and critically evaluate its role in financial services.
CO2	Ability to apply the concept of new generation commerce and new operating models for banks.
CO3	Knowledge to use the concepts of FinTech in wealth management, personal finance management, crowd funding and crowd investing.
CO4	Apply the concept of cryptocurrencies, risk associated with crypto market and cost involved.
CO5	Critically evaluate the role of FinTech in financial services and understand recent developments such as Distributed ledger for identification, Identification for Unbanked-Unique identification system in India, Cybercrime, Cyber security categories

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	1	2	2	2	1	1	2	1	3	1	-	-	1	1
CO2	3	3	2	3	2	2	2	2	3	1	3	2	-	-	1	1
CO3	3	3	3	3	3	3	2	2	3	1	3	3	-	-	1	1
CO4	3	3	2	3	3	2	2	2	2	1	3	2	-	-	1	1
CO5	3	3	1	2	2	2	2	2	2	1	3	1	-	-	1	1

OME424	**Sustainable Manufacturing**	**L**	**T**	**P**	**C**
	Common to CSE, IT, ADS, EEE, Mechanical Departments	3	0	0	3

COURSE OBJECTIVES

To impart knowledge on the following topics:

- To provide students with knowledge of key environmental and sustainability issues relevant to modern manufacturing.
- To provide a set of tools and skills that may be used to design, analyze, and improve manufacturing Processes, products, and business operations.

UNIT I	**Need for Sustainable Manufacturing**	**9**
Introduction to the environmental issues pertaining to the manufacturing sector – pressure to reduce costs – processes that minimize negative environmental impacts – environmental legislation and energy costs – acceptable practice in society – adoption of low carbon technologies – need to reduce the carbon footprint of manufacturing operations.		**CO1**
UNIT II	**Techniques for non-market valuation**	**9**
Cost and income-based approaches, demand estimation methods – expressed and revealed preference, choice modelling – Multi-criteria analysis- Stakeholder analysis – Environmental accounting at sector and national levels		**CO2**
UNIT III	**Sustainability performance evaluators and Principles of sustainable operations**	**9**
Frameworks and techniques – environmental management systems – life cycle assessment – strategic and environmental impact assessments – carbon and water foot-printing. Life cycle assessment Manufacturing and service activities –Influence of product design on operations – Process analysis – Capacity management – Quality management –Inventory management – Just-In-Time systems – Resource efficient design – Consumerism and sustainable well-being.		**CO3**
UNIT IV	**Strategies and Design Approaches**	**9**
Concepts of Competitive Strategy and Manufacturing Strategies and development of a strategic improvement programme – Manufacturing strategy in business - success Strategy formation and formulation – Structured strategy formulation – Sustainable manufacturing system design options – Approaches to strategy formulation – Realization of new strategies/system designs		**CO4**
UNIT V	**Challenges and Opportunities**	**9**
Challenges in logistics and supply chain – developing the right supply chain strategy for the products – need to align the supply network around the strategy – Tools that can be used systematically to identify areas for improvement in supply chains – Specific challenges and new thinking in the plan, source and delivering of sub-processes.		**CO5**
	Total Hours:	**45**
	TEXTBOOKS	
1.	Seliger, G,(2012), Sustainable Manufacturing: Shaping Global Value Creation, Springer	
2.	Davim, J.P.(2010), Sustainable Manufacturing, John Wiley & Sons.	
	REFERENCE BOOKS	
1.	Gupta, S.M. and Lambert, A.J.D.(2008), Environment Conscious Manufacturing, CRC Press	
2.	Douglas C.Montgomery, "Design and Analysis of Experiments", 5th Edition, John Wiley	
	COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	Identify key requirements and concepts in lean manufacturing.	
CO2	Understand the need for sustainability assessment and their types.	
CO3	Develop sustainability assessment framework model depending on the process under investigation.	
CO4	To Frame Strategic polices and implement sustainability approaches	
CO5	Apply knowledge of lean and other sustainability concepts in a typical sustainable manufacturing setup.	

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3

COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	3	-	-	3	-	-	-	-	3	-	-	1	1
CO2	3	2	3	3	-	-	3	-	-	-	-	3	-	-	1	1
CO3	3	2	3	3	-	-	3	-	-	-	-	3	-	-	1	1
CO4	3	2	3	3	-	-	3	-	-	-	-	3	-	-	1	2
CO5	3	2	3	3	-	-	3	-	-	-	-	3	-	-	1	2

OEC414	BIOMEDICAL INSTRUMENTATION	L	T	P	C
Common to CSE, IT, ADS, EEE, Mechanical Departments		3	0	0	3

COURSE OBJECTIVES

To impart knowledge on the following topics:

- To study about the biopotentials and its propagation
- To understand the different types of electrodes and its placement for various recording
- To study the design of bio amplifier for various physiological recording
- To learn different measurement techniques for non-physiological parameters
- To discuss the recent trends in the field of diagnostic and therapeutic equipment

UNIT I	BIOPOTENTIAL RECORDING AND ELECTRODE TYPES	9
Biopotential origin and its propagation. Types of electrodes and its equivalent circuits - surface, needle and micro electrodes. Recording problems - measurement with two electrodes		CO1
UNIT II	**FEATURES OF BIOSIGNAL AND ELECTRODE CONFIGURATIONS**	**9**
Features of Bio-signal – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – unipolar, bipolar, average mode and 10-20 electrode system. EMG– unipolar and bipolar mode.		CO2
UNIT III	**BIOAMPLIFIER CIRCUITS AND ASSIST DEVICES**	**9**
Basic requirements for bio-amplifier - differential bio-amplifier, PLI, Right leg driven ECG amplifier, Band pass filtering. Assist Devices- Dialyzer, Cardiac Pacemakers, and Heart Lung Machine.		CO3
UNIT IV	**MEASUREMENT OF NON-ELECTRICAL AND BIO-CHEMICAL PARAMETERS**	**9**
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method. Calorimeter, Sodium Potassium Analyzer, auto analyzer (simplified schematic description).		CO4
UNIT V	**CURRENT TRENDS IN MEDICAL DEVICES**	**9**
Laser in medicine and its applications, Thermograph – System, working, endoscopy unit, Cryogenic application, Introduction to tele-medicine.		CO5
	Total Hours:	**45**

	TEXTBOOKS
1.	Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi,2007.
2.	John G. Webster, "Medical Instrumentation: Application and Design", John Wiley and sons, NewYork,2004.(Unit I,II&III).

	REFERENCE BOOKS
1.	MyerKutz, “Standard Handbook of Biomedical Engineering and Design”, McGraw Hill Publisher, 2003.
2.	Chan and Anthony Y.K, ’’Biomedical Device Technology: Principles and Design’’, Springfield, Illinois : Charles C. Thomas publisher Limited,2016.
3.	Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, NewDelhi, 2003.(Unit II&IV)
4.	Chan and Anthony Y.K, ’’Biomedical Device Technology: Principles and Design’’, Springfield, Illinois : Charles C. Thomas publisher Limited,2016.
	COURSE OUTCOMES Upon completion of the course, students will be able to
CO1	To acquire knowledge about biopotentials and its propagation
CO2	To get familiarized with different electrode placements for various physiological recording
CO3	To design bio amplifiers for various physiological recording
CO4	To understand various techniques for non-electrical and physiological measurements
CO5	To understand the recent trends in the field of diagnostic and therapeutic equipment

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	**2**	**2**	**2**	**-**	**1-**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO2	**2**	**2**	**2**	**-**	**1-**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**1**
CO3	**3**	**3**	**3**	**-**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**3**	**3**	**2**
CO4	2	2	3	-	3	3	-	-	2	-	-	-	2	3	3	2
CO5	2	2	3	-	3	3	-	-	2	-	-	-	2	3	3	2

OPEN ELECTIVE -III

OIT411	FUNDAMENTALS OF DATABASE DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The role of database management system in an organization and learn the database concepts.
- The design databases using data modelling and data normalization techniques.
- Construct database queries using relational algebra and calculus.
- The concept of a database transaction and related database facilities.
- To learn the basic concepts of Transactions, concurrency control techniques, and recovery procedures

UNIT-1	CONCEPTUAL MODELLING	9
Introduction database design -Database Environment, - Data Models: Entity Relationship Model, Relational Model- Database Development Lifecycle		
UNIT-2	**RELATIONAL MODELS**	**9**
Integrity Constraints- SQL Data Manipulation and Definition- Views- Relational Models- Hierarchical and Network		
UNIT-3	**INTRODUCTION TO SQL**	**9**
Introduction to Structured Query Language-DDL Commands-DML Commands-TCL Commands -views-Index-Synonyms- Sub queries- SQL Functions-Joins-PL/SQL–simple programs		
UNIT-4	**RELATIONAL DATABASE DESIGN AND NORMALIZATION**	**9**
ER and EER to relationship Model-ER Diagrams- -Functional Dependencies-First, Second and Third Normal Forms-Dependency preservation		
UNIT-5	**TRANSACTION MANAGEMENT**	**9**
Transaction Concepts- Properties- Schedules- Serializability- Concurrency Control – Two phase locking techniques		
Total Hours:		**45**

	TEXT BOOKS
1.	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 4thEdition, 2002.
	REFERENCE BOOKS
1. 2. 3. 4. 5.	Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 3rdEdition, 2003. Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 3rd Edition, 2003. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database System Implementation", Pearson Education, United States, 1st Edition, 2000. Peter Rob, Corlos Coronel, "Database System, Design, Implementation and Management", Thompson Learning Course Technology, 5th Edition, 2003.
	COURSE OUTCOMES: On completion of the course, the students will be able to:
CO1	The fundamentals of Database systems are vital components of modern information systems.

CO2	Understand the need for Databases and relational Model concepts.
CO3	Database applications all pervasive and range in size from small in-memory databases to terabytes or even larger in various applications domains.
CO4	The course focuses and the fundamentals of knowledgebase and relational database management systems, and the current developments in database theory and their practices.
CO5	Write Queries in SQL and execute multiple sub-queries, functions and joins.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMMESPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	3	2	1	-	-	-	2	1	1	1	-	-	2	1
CO2	3	1	1	1	1	-	-	-	2	3	3	3	-	-	2	1
CO3	3	2	3	2	1	-	-	-	3	2	3	3	-	-	2	1
CO4	1	2	3	2	-	-	-	-	1	3	3	1	-	-	2	1
CO5	1	1	3	3	2	-	-	-	2	2	2	2	-	-	2	1

OMA421	**ALGEBRA AND NUMBER THEORY**	**L**	**T**	**P**	**C**
		3	0	0	3

OBJECTIVES:

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To introduce and apply the concepts of rings, finite fields and polynomials.
- To understand the basic concepts in number theory
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

UNIT I	**GROUPS AND RINGS**	**9**
Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem. Rings: Definition - Sub rings - Integral domain - Field - Integer modulo *n* - Ring homomorphism.		**CO1**
UNIT II	**FINITE FIELDS AND POLYNOMIALS**	**9**
Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.		**CO2**
UNIT III	**DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**	**9**
Division algorithm – Base - b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.		**CO3**
UNIT IV	**DIOPHANTINE EQUATIONS AND CONGRUENCES**	**9**
Linear Diophantine equations – Congruence's – Linear Congruence's - Applications: Divisibility tests - Modular exponentiation-Chinese remainder theorem – 2 x 2 linear systems.		**CO4**
UNIT V	**CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**	**9**

Wilson's theorem – Fermat's little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.	**CO5**
TOTAL : 45 HOURS	

TEXT BOOKS:
1. Grimaldi, R.P. and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007. 2. Koshy, T., "Elementary Number Theory with Applications", Elsevier Publications, New Delhi, 2002.
REFERENCE BOOKS:
1. Lidl, R. and Pitz, G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition, 2006. 2. Niven, I., Zuckerman. H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers", John Wiley and Sons, Singapore, 2004. 3. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.

COURSE OUTCOMES **Upon completion of the course, students will be able to**	
CO1	Apply the basic notions of groups, rings, fields which will then be used to solve related problems.
CO2	Explore of advanced algebraic techniques and demonstrating accurate and efficient use of the same with context to extending concept related to polynomials.
CO3	Understand the basic concepts in number theory and approach into the analysis of numbers
CO4	Apply the basic ideas of number theory to real world problems by the way of congruence and Linear Diophantine equations and Chinese remainder theorem.
CO5	Understand the three classical theorems, apply the same to solve the non - trivial problems related to the field and have strong foundation in dealing with numbers.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**											**PROGRAM SPECIFIC OUTCOMES (PSOs)**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3	2	2	1	1	1	1	1	1	1	-	1	-	1	1
CO2	3	3	2	1	1	1	-	1	1	1	-	1	1	-	1	1
CO3	3	3	2	1	2	1	-	1	2	2	-	-	1	-	2	1
CO4	3	3	2	2	1	1	-	2	1	1	1	1	1	-	2	1
CO5	3	3	2	1	1	1	1	1	2	1	1	-	1	-	1	1

OCS432	DEEP LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic ideas and principles of neural networks.
- To understand the basic concepts of deep learning.
- To appreciate the use of deep learning applications.

UNIT I	BASICS OF NEURAL NETWORKS	9
Basic Concept of Neurons – Perceptron Algorithm – Feed Forward and Backpropagation Networks.		CO1
UNIT II	**INTRODUCTION TO DEEP LEARNING**	**9**
Deep Feed-Forward Neural Networks – Gradient Descent – Back-Propagation and Other Differentiation Algorithms – Vanishing Gradient Problem – Mitigation – Rectified Linear Unit (ReLU) – Heuristics for Avoiding B ad Local Minima – Heuristics for Faster Training – Nestors Accelerated Gradient Descent – Regularization for Deep Learning – Dropout – Adversial Training – Optimization for Training Deep Models.		CO2
UNIT III	**CONVOLUTIONAL NEURAL NETWORKS**	**9**
CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning – Recurrent and Recursive Nets – Recurrent Neural Networks – Deep Recurrent Networks – Recursive Neural Networks – Applications.		CO3
UNIT IV	**UNSUPERVISED DEEP LEARNING**	**9**
Autoencoders – Standard – Sparse – Denoising – Contractive – Variational Autoencoders- Adversarial Generative Networks - Deep Boltzmann Machine (DBM)		CO4
UNIT V	**APPLICATIONS OF DEEP LEARNING**	**9**
Images segmentation – Object Detection – Multi class Object Detection - Object Classification and Localization- Automatic Image Captioning – Image generation with Generative adversarial networks– Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks – Sentence Classification using Convolutional Neural Networks – Dialogue Generation with LSTMs		CO5
Total Hours:		**45**

	TEXT BOOKS
1.	Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
2.	Francois Chollet, "Deep Learning with Python", Manning Publications, 2018
	REFERENCE BOOKS
1.	Phil Kim, "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress, 2017.
2.	Ragav Venkatesan, Baoxin Li, "Convolutional Neural Networks in Visual Computing", CRC Press, 2018.
3.	Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
4.	Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications, 2016.
5.	Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
	COURSE OUTCOMES:

	On completion of the course, the students will be able to:
CO1	Understand the role of deep learning in machine learning applications.
CO2	Design and implement deep learning applications.
CO3	Critically analyze different deep learning models in image related projects.
CO4	Design and implement convolutional neural networks.
CO5	Know about applications of deep learning in NLP and image processing.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMMESPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3	2	2	-	-	-	-	2	2	-	-	2	1
CO2	3	3	3	3	2	2	-	-	-	-	2	2	-	-	2	1
CO3	3	3	3	3	2	2	-	-	-	-	2	2	-	-	2	1
CO4	3	3	3	3	2	2	-	-	-	-	2	2	-	-	2	1
CO5	3	2	2	2	3	2	-	-	-	-	1	2	-	-	2	1

OMB432	**OPERATIONAL RESEARCH**	**L**	**P**	**T**	**C**
		3	0	0	3

OBJECTIVES

- To classify and formulate real-life problem for modelling, solving and applying for decision making.
- To study the formulation and various methods of solutions for linear programming, transportation, assignment , CPM and PERT problems
- To solve problems using dynamic programming method

UNIT I	**LINEAR MODELS**	**9**
Introduction to operations research-Linear programming problems (LPP)-Graphical method-Simplex method-Big M Method-Dual simplex method-Primal Dual problems -Dual theory and Sensitivity analysis.		**CO1**
UNIT II	**TRANSPORTATION MODELS**	**9**
Transportation and assignment problems-Applications (Emphasis should be more on problems than theory)		**CO2**
UNIT III	**NETWORK MODELS**	**9**
Shortest path problem: Dijkstra's algorithms, Floyd's algorithm, systematic method – CPM / PERT–Network diagram-Events and activities-Project Planning-Reducing critical events and activities-Critical path calculations-example-Sequencing problems.		**CO3**
UNIT IV	**DECISION MODELS AND INVENTORY MODELS**	**9**
Replacement problems-Capital equipment-Discounting costs-Group replacement. Inventory models-various costs- Deterministic inventory models-Economic lot size-Stochastic inventory models-Single period inventory models with shortage cost.		**CO4**
UNIT V	**QUEUING MODELS**	**9**
Characteristics of Queuing Models – Single and multi server models Poisson Queues - (M / M / 1) : (FIFO / ∞ /∞), (M / M / 1) : (FIFO / N / ∞), (M / M / C) : (FIFO / ∞ / ∞), (M / M / C) : (FIFO / N / ∞) models.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. H. A. Taha, operational research-An introduction, Macmillan, 1976

2. F. S. Hiller and G. J. Liebermann, Introduction to operational research (7th edition)
3. B. E. Gillet, Introduction to operational research-A computer oriented algorithmic approach, McGraw Hill, 1989
4. H. M. Wagner, Principles of operational research with applications to managerial decisions, PH, Inc, 1975

REFERENCE BOOKS

1. Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 2009.
2. Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.
3. Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992. Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.
4. Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.
5. J. C. Pant, 'Introduction to Optimisation: Operations Research', Jain Brothers, Delhi, 2008.
6. Pannerselvam, 'Operations Research', Prentice Hall of India 2010.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To analyze the problems in engineering, management or business environment, focusing on important details
CO2	To formulate real problems in terms of input-output parameters relationships and identify the solution procedure
CO3	To understand the concept of network and project planning
CO4	To understand the inventory management in manufacturing context
CO5	To understand the application of queuing theory in real world

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMMESPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	3	3	3	3	2	1	1	1	2	2	2	-	-	1	1
CO2	2	3	3	3	3	2	1	1	1	1	2	2	-	-	1	1
CO3	2	3	3	3	3	2	1	1	1	1	2	2	-	-	1	1
CO4	2	3	3	3	3	3	1	1	1	1	2	2	-	-	1	1
CO5	2	3	3	3	3	3	1	1	1	2	2	2	-	-	1	1

OME427	**REVERSE ENGINEERING**	**L**	**T**	**P**	**C**
	Common to ECE, CSE, IT & ADS	3	0	0	3

OBJECTIVES

- .To learn the need for and the various tools required for reverse engineering
- To know the important research challenges associated with Reverse engineering
- To study the various concepts in quality and reliability principles in the design of an engineering product

UNIT I	**INTRODUCTION**	**9**
Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.		**CO1**

UNIT II	TOOLS FOR REVERSE ENGINEERING	9
Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application prototyping – verification.		CO2
UNIT III	**CONCEPTS OF REVERSE ENGINEERING**	**9**
History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation.		CO3
UNIT IV	**DATA MANAGEMENT**	**9**
Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics		CO4
UNIT V	**INTEGRATION OF REVERESE ENGINEERING**	**9**
Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -–coordinate measurement – feature capturing – surface and solid members		CO5
		TOTAL: 45 HOURS

	TEXTBOOKS
	1. Kevin Otto & Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2011. 2. Reverse Engineering: Mechanisms, Structures, Systems & Materials 1st Edition by Robert W. Messler Jr. Dec 10, 2013
	REFERENCE BOOKS
	1. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011. 2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", secon edition, World Scientific Publishers, 2010. 3. Kathryn, A. Ingle, Reverse Engineering, McGraw-Hill

COURSE OUTCOMES
Upon completion of the course, students will be able to

CO1	Understand need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering.
CO2	Understand select the suitable tools and methodology for reverse engineering for any product.
CO3	Understand important research challenges associated with Reverse engineering and its data processing tools.
CO4	Understand important integrating reverse engineering, reuse and specification tool environments to reverse engineering
CO5	Understand with various concepts in quality and reliability principles in the design of an engineering product or a service.

MAPPING OF COs WITH POs AND PSOs

COs	**PROGRAM OUTCOMES (POs)**	**PROGRAM SPECIFIC**

													OUTCOMES (PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	-	2	-	2	-	-	-	-	3	-	-	2	1
CO2	3	3	3	-	2	-	2	-	-	-	-	3	-	-	2	1
CO3	3	3	3	-	2	-	2	-	-	-	-	3	-	-	2	1
CO4	3	3	3	-	2	-	2	-	-	-	-	3	-	-	2	1
CO5	3	3	3	-	2	-	2	-	-	-	-	3	-	-	2	1

OME429	**Introduction to Industrial Automation**	**L**	**T**	**P**	**C**
	Common to Electronics and Communication Engineering	3	0	0	3

OBJECTIVES

- To learn the applications of industrial automation and robotics
- To know about worker machine systems and outline automation principles
- To study about the Model Flexible Manufacturing Systems

UNIT I	**INDUSTRIAL AUTOMATION AND ROBOTICS**	**9**
Introduction to automation- Architecture of industrial automation systems- Introduction to Robotics - Classification of Robots and Characteristics- NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Industrial applications.		**CO1**
UNIT II	**PRODUCTION SYSTEM**	**9**
Production systems- Facilities – Manual work systems- worker-machine systems and automated systems - Manufacturing support Systems-Automation in Production systems – Automated Manufacturing systems -Computerized manufacturing support systems - Manual labour in Production systems-Automation principles and strategies.		**CO2**
UNIT III	**AUTOMATED TRANSPORTATION AND STORAGE**	**9**
Automated Guided Vehicle (AGV) Systems-Types of vehicles- AGV Applications-Vehicle Guidance Technology-Vehicle Management and Vehicle Safety-Automated Storage/Retrieval Systems (ASRS) and Carousel Storage Systems - Vehicle Management and Vehicle safety.		**CO3**
UNIT IV	**CELLULAR MANUFACTURING SYSTEMS (CMS)**	**9**
Role of Group Technology (GT) in Computer Aided Manufacturing- Features of GT- Cellular manufacturing- Role of similarity in GT- Coding-Classification and clustering- Production flow analysis-CMS design factors.		**CO4**
UNIT V	**FLEXIBLE MANUFACTURING SYSTEM (FMS)**	**9**
Types of automation, Flexibility- Types of FMS- FMS Layout configuration- Automated work piece flow-Material handling and machining- Performance measures – Bottleneck model – Extended bottleneck model – Sizing of FMS- FMS Scheduling and Control.		**CO5**
		TOTAL: 45 HOURS

	TEXTBOOKS
	John Nicholas, Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities, McGraw-Hill International Editions,19982. Sing N, and Rajamani, D, Cellular Manufacturing Systems: Design, Planning & Control, First Edition, Chapman & Hall,1996.

	REFERENCE BOOKS
	Mikell P. Groover, Automation, Production Systems, and Computer-Integrate Manufacturing, 2nd Edition, Prentice Hall of India Private Limited, 2001. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi 2009. Askin, R. G, and Standridge, C. R, Modelling and Analysis of Manufacturing Systems, John Wiley & sons Inc.,1993.
COURSE OUTCOMES **Upon completion of the course, students will be able to**	
CO1	Appraise the applications of industrial automation and robotics.
CO2	Categorize manual and worker machine systems and outline automation principles
CO3	Organize the role of automated transportation and storage systems.
CO4	Recall role of Group Technology and design Cellular manufacturing systems.
CO5	Model Flexible Manufacturing Systems and study its performance measures.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMMESPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	-	3	-	2	-	-	-	-	-	-	3	-	-	1	1
CO2	3	-	3	-	2	-	-	-	-	-	-	3	-	-	1	1
CO3	3	-	3	-	2	-	-	-	-	-	-	3	-	-	1	1
CO4	3	-	3	-	2	-	-	-	-	-	-	3	-	-	1	1
CO5	3	-	3	-	2	-	-	-	-	-	-	3	-	-	1	1

ELECTIVE - MANAGEMENT COURSES

MB4751	**PRINCIPLES OF MANAGEMENT**	**L**	**P**	**T**	**C**
		3	0	0	3

OBJECTIVES

- To enable the students to study the evolution of Management.
- To study the functions and principles of management.
- To learn the application of the principles in an organization.
- To acquire the skills of effective leadership and communication.
- To gain the knowledge of tools and techniques for an effective managerial skill.

UNIT I	**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**	**9**
Definition of Management – Science or Art – Manager Vs Entrepreneur – Types of managers – managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization – Sole proprietorship, partnership, company – Public and private sector enterprises – Organization culture and Environment – Current trends and issues in Management.		**CO1**
UNIT II	**PLANNING**	**9**
Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.		**CO2**
UNIT III	**ORGANISING**	**9**
Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – Delegation of authority – Centralization and decentralization – Job Design – Human Resource Management – HR Planning,		**CO3**

Recruitment, selection, Training and Development, Performance Management, Career planning and management.		
UNIT IV	**DIRECTING**	**9**
Foundations of individual and group behaviour – Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – Types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.		**CO4**
UNIT V	**CONTROLLING**	**9**
System and process of controlling – Budgetary and non–budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India), Pvt. Ltd., 15th Edition, 2020.

REFERENCE BOOKS

1. Harold Koontz & Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 10th Edition, 2015.
2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 11th Edition, Pearson Education, 2017.
4. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 6th Edition 2017.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Ability to understand the various terms and definitions related to management and organization.
CO2	Ability to acquire the skill of planning and various strategies of management in an organization.
CO3	Ability to understand the types of organization and also get an insight into HR planning, recruitment, selection and career planning and management.
CO4	Ability to acquire the skills of leadership and understand the importance of communication to run an organization effectively.
CO5	Ability to understand the concept of budget and budgetary control and acquire the skill of controlling technique.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	1	1	1	1	1	3	1	2	3	1	1	2	-	-	1	3
CO2	1	2	3	2	2	3	2	2	3	2	1	2	-	-	1	3
CO3	1	2	3	1	2	3	2	2	3	3	1	2	-	-	1	3
CO4	1	2	2	1	2	3	1	2	3	3	1	2	-	-	1	3

CO5	1	2	3	2	3	3	1	2	3	1	1	2	-	-	1	3

MB4741	**TOTAL QUALITY MANAGEMENT**	**L**	**P**	**T**	**C**
		3	0	0	3

OBJECTIVES

- To facilitate the understanding of Quality Management principles and process.

UNIT I	**INTRODUCTION**	**9**
Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.		**CO1**
UNIT II	**TQM PRINCIPLES**	**9**
Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.		**CO2**
UNIT III	**TQM TOOLS AND TECHNIQUES I**	**9**
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to benchmark, Bench marking process - FMEA - Stages, Types.		**CO3**
UNIT IV	**TQM TOOLS AND TECHNIQUES II**	**9**
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.		**CO4**
UNIT V	**QUALITY MANAGEMENT SYSTEM**	**9**
Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration-- ENVIRONMENTAL MANAGEMENTSYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001— Requirements of ISO 14001— Benefits of EMS.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Dale H. Besterfiled, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality",8th Edition, First Indian Edition, Cengage Learning, 2012.

REFERENCE BOOKS

1. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases",Prentice Hall (India) Pvt. Ltd., 2006.
2. Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt.Ltd., 2006.
3. ISO9001-2015 standards

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	The students can understand the principles of quality management and to explain how these principles can be applied within quality management systems.

CO2	Students can identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
CO3	Students can understand the Organisational, communication and teamwork requirements for effective quality management
CO4	Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans
CO5	The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	3	3	1	1	1	2	3	1	3	-	-	1	3
CO2	3	2	3	3	3	1	1	1	2	2	1	3	-	-	1	3
CO3	3	2	3	3	3	1	1	1	2	3	1	3	-	-	1	3
CO4	3	2	3	3	3	1	1	1	2	2	1	3	-	-	1	3
CO5	2	2	3	1	1	1	1	1	2	3	1	3	-	-	1	3

MB4043	**ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING**	**L**	**P**	**T**	**C**
		3	0	0	3

OBJECTIVES

- To make the Engineering student to know about the basic of economics & how to organize a business
- To know the financial aspects related to business.
- To know about functions of banks.
- To understand the different methods of appraisal of projects and
- To know about the break even analysis

UNIT I	**Basic Economics**	**9**
Definition of economics – nature and scope of economics – micro economics and macro economics – factors of production – demand analysis – definition of demand – Law of demand – Exception to law of demand – Factors affecting demand – elasticity of demand – demand forecasting – definition of supply – factors affecting supply – elasticity of supply – market structure – perfect competition – imperfect competition - monopoly – duopoly – oligopoly and bilateral monopoly .		**CO1**
UNIT II	**Organization and Business Financing**	**9**
Forms of business – proprietorship – partnership - joint stock company - cooperative organization – state Enterprise - mixed economy - Money and banking – kinds of banking - commercial banks - central banking functions - control of credit - monetary policy - credit instrument – Types of financing - Short term borrowing - Long term borrowing - Internal generation of funds - External commercial borrowings - Assistance from government budgeting support and international finance corporations.		**CO2**
UNIT III	**Financial Accounting**	**9**

Introduction to Financial Accounting – Accounting Principles – Types of Accounts – Final Accounts: Trading Account, Profit and Loss Account and Balance Sheet. Financial Ratio Analysis - fund flow analysis and Cash flow analysis (only theory)		**CO3**
UNIT IV	**Capital Budgeting and Cost Analysis**	**9**
Capital budgeting– Average rate of return – Payback period – Profitability index - Net present value and Internal rate of return. Types of costing – traditional costing approach - activity based costing - Fixed Cost – variable cost – marginal cost - Cost sheet – Basic Problems in cost sheet.		**CO4**
UNIT V	**Break Even Analysis and Project Feasibility**	**9**
Break Even Analysis – definition - managerial uses of break even analysis – Break even chart – concepts in marginal costing - applications of break even analysis in engineering projects - Appraising project profitability - cost benefit analysis – feasibility reports – appraisal process – technical feasibility - economic feasibility – financial feasibility.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Khan MY and Jain PK, "Financial Management", McGraw - Hill Publishing Co., Ltd., 3rd Edition, New York, 2017.
2. Varshney RL and Maheshwari KL, "Managerial Economics", S Chand and Co., 22nd New Delhi, 2014.

REFERENCE BOOKS

1. Samuelson P.A, "Economics - An Introductory" Text Book, New Age Publications ,New Delhi,2009
2. S. K. Bhattacharyya , John Deardon and Y. K. Koppikar, Accounting for Management Text and Cases". Barthwal R.R., " Industrial Economics - An Introductory" Text Book, New Age Publications, New Delhi,2010
3. V. L .Mote, Samuel and G. S. Gupta, "Managerial Economics - Concepts and Cases", Tata Mcgraw Hill,2011

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Identify suitable demand forecasting techniques and prevailing market structure.
CO2	Describe the forms of business and differentiate between proprietorship and partnership.
CO3	Explain the kinds of banks and illustrate the Balance sheet, ratios, and cash and fund flow.
CO4	Interpret fixed cost and variable cost and capital budgeting.
CO5	The managerial uses of break even analysis and financial feasibility and economic feasibility.

MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3

COs	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1	1	1	1	1	1	2	3	2	-	-	1	3
CO2	1	2	2	1	1	1	1	1	1	2	3	2	-	-	1	3
CO3	1	3	3	3	3	1	1	1	1	2	3	2	-	-	1	3
CO4	1	3	3	3	3	1	1	1	1	3	3	2	-	-	1	3
CO5	1	3	3	3	3	2	1	1	1	3	3	2	-	-	1	3

MB4203	HUMAN RESOURCE MANAGEMENT	L	P	T	C
		3	0	0	3

OBJECTIVES

- To learn the basic concepts of Human Resource Management
- To understand the importance of Human Resource Planning and Recruitment
- To understand the fundamentals and importance of Training and Development
- To understand the intricacies in Employee Engagement
- To understand the importance of Performance Evaluation and Control

UNIT I	**PERSPECTIVES IN HUMAN RESOURCE MANAGEMENT**	**9**
Evolution of human resource management – The importance of the human capital – Role of human resource manager – Challenges for human resource managers - trends in Human resource policies – Computer applications in human resource management – Human resource accounting and audit.		**CO1**
UNIT II	**HUMAN RESOURCE PLANNING AND RECRUITMENT**	**9**
Importance of Human Resource Planning – Forecasting human resource requirement – matching supply and demand – Internal and External sources – Organizational Attraction - Recruitment, Selection, Induction and Socialization - Theories, Methods and Process.		**CO2**
UNIT III	**TRAINING AND DEVELOPMENT**	**9**
Types of training methods – purpose – benefits - resistance. Executive development programme – Common practices – Benefits – Self-development – Knowledge management.		**CO3**
UNIT IV	**EMPLOYEE ENGAGEMENT**	**9**
Compensation plan – Reward – Motivation – Application of theories of motivation – Career management – Mentoring - Development of mentor – Protégé relationships- Job Satisfaction, Employee Engagement, Organizational Citizenship Behavior: Theories, Models.		**CO4**
UNIT V	**PERFORMANCE EVALUATION AND CONTROL**	**9**
Method of performance evaluation – Feedback – Industry practices. Promotion, Demotion, Transfer and Separation – Implication of job change. The control process – Importance – Methods – Requirement of effective control systems grievances –Causes – Implications – Redressal methods.		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Gary Dessler and Biju Varkkey, Human Resource Management,14th Edition, Pearson Education Limited, 2015.
2. David A. Decenzo, Stephen. P. Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014.
3. Luis R. Gomez - Mejia, David B. Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012

REFERENCE BOOKS

1. Bernadin, Human Resource Management, Tata McGraw Hill, 8th edition 2012.
2. Wayne Cascio, Managing Human Resource, McGraw Hill, 2015.
3. Ivancevich, Human Resource Management, McGraw Hill 2012.
4. Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To understand the various aspects of HR
CO2	To gain knowledge on Human Resource Management skills
CO3	To develop the skills needed to be an Human Resource Manager

CO4	To understand the concepts of work place management
CO5	To understand and applications of new trends in the area of Human Resource management

MAPPING OF COs WITH POs AND PSOs

COs	PROGRAM OUTCOMES (POs)										PROGRAM SPECIFIC OUTCOMES (PSOs)		
	PO1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO8	PO9	PO1 0	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	2	1	1	2	1	3	3	3
CO2	3	3	2	3	2	2	2	2	3	1	3	3	3
CO3	3	3	3	3	3	3	2	2	3	1	3	2	2
CO4	3	3	2	3	3	2	2	2	2	1	3	3	3
CO5	3	3	1	2	2	2	2	2	2	1	3	2	3

MB4044	KNOWLEDGE MANAGEMENT	L	P	T	C
		3	0	0	3

OBJECTIVES

- To make the students realize the importance of capturing knowledge elements and its structures application as a competitive advantage to business.
- To understand different components knowledge management.
- To conduct knowledge audit and knowledge management practices in organization.

UNIT I	INTRODUCTION	9
An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- History of KM-technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management : From Information Management to Knowledge Management - K M Cycle, Industrial Economy to Knowledge Economy.Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.		CO1
UNIT II	**CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING**	**9**
Mechanics of Knowledge Management–Tools and Technologies, Communities of Practice and Knowledge conversion, The knowledge Management Matrix- Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.		CO2
UNIT III	**KNOWLEDGE MANAGEMENT-THE TOOLS**	**9**
Social Nature of Knowledge, Social Network Analysis, Obstacles to knowledge sharing, Organizational learning & Social Capital. Knowledge Application – Individual level, Group level & Organization Level - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.		CO3

UNIT IV	KNOWLEDGE MANAGEMENT-APPLICATION	9
KM Strategy, Knowledge audit, GAP Analysis, Road Map, KM Metrics, Balance Score Card.KM Tools – Knowledge Capture & Creation tools, Knowledge sharing & Dissemination Tools, Knowledge Acquisition & Application tools-Components of a Knowledge Strategy		**CO4**
UNIT V	**FUTURE TRENDS**	**9**
Km Team–Roles & Responsibilities, Political issues in KM, Ethics in KM, Strategies issues in Knowledge Management, Future of Knowledge Management- Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan .		**CO5**
		TOTAL : 45 HOURS

TEXT BOOKS

1. Srikantaiah.T. K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.
2. Knowledge Management – a resource book – A Thohothathri Raman, Excel, 2004.
3. Knowledge Management- Elias M. Awad Hasan M. Ghazri, Pearson Education

REFERENCE BOOKS

1. The KM Toolkit – Orchestrating IT, Strategy & Knowledge Platforms, Amrit Tiwana, Pearson, PHI, II Edn.
2. The Fifth Discipline Field Book – Strategies & Tools For Building A learning Organization – PeterSenge et al. Nicholas Brealey 1994
3. Knowledge Management – Sudhir Warier, Vikas publications
4. Leading with Knowledge, Madanmohan Rao, Tata Mc-Graw Hill

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To understand the various aspects of Knowledge Management
CO2	To Formulate action plans for knowledge intensive organisations.
CO3	To develop the culture of learning in an organization.
CO4	To understand the Knowledge management Tools.
CO5	To understand and applications of new trends in knowledge Management

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	1	2	2	2	1	1	2	1	3	2	-	-	1	3
CO2	3	3	2	3	2	2	2	2	3	1	3	2	-	-	1	3
CO3	3	3	3	3	3	3	2	2	3	1	3	2	-	-	1	3

CO4	3	3	2	3	3	2	2	2	2	1	3	2	-	-	1	3
CO5	3	3	1	2	2	2	2	2	2	1	3	2	-	-	1	3

GE4792	**INDUSTRIAL MANAGEMENT**	**L**	**T**	**P**	**C**
	Common to ECE and MECH	3	0	0	3

OBJECTIVES

- To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

UNIT I	**INTRODUCTION**	**9**
Management - Definition – Functions – Evolution of Modern Management – Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization – Individual Ownership – Partnership – Joint Stock Companies – Co-operative Enterprises – Public Sector Undertakings, Corporate Framework – Share Holders – Board of Directors – Committees – Chief Executive –Trade Union		**CO1**
UNIT II	**FUNCTIONS OF MANAGEMENT**	**9**
Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing – Nature and Process – Premises – Departmentalization – Line and staff – Decentralization – Organizational culture, Staffing - selection and training – Placement – Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor – Leadership – Communication, Controlling - Process of Controlling – Controlling techniques, productivity and operations management – Preventive control, Industrial Safety.		**CO2**
UNIT III	**ORGANIZATIONAL BEHAVIOUR**	**9**
Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Perception – Organizational Implications. Personality – Contributing factors - Dimension – Need Theories – Process Theories – Job Satisfaction, Learning and Behavior – Learning Curves, Work Design and approaches.		**CO3**
UNIT IV	**GROUP DYNAMICS**	**9**
Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, leadership – formal and informal characteristics – Managerial Grid – Leadership styles – Group Decision Making – Leadership Role in Group Decision, Group Conflicts – Types – Causes – Conflict Resolution – Inter group relations and conflict, Organization centralization and decentralization – Formal and informal – Organizational Structures – Organizational Change and Development – Change Process –		**CO4**
UNIT V	**MODERN CONCEPTS**	**9**
Management by Objectives (MBO), Management by Exception (MBE), Strategic Management - Planning for Future direction – SWOT Analysis – Information technology in management – Decisions support system – Business Process Re-engineering (BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM).		**CO5**

	TOTAL: 45 HOURS
	TEXTBOOKS
	1. Herald Knottz and Heinz Weihrich, "Essentials of Management", Tata McGraw Hill Education Pvt. Ltd., 2010. 2. Stephen P. Robbins, "Organization Behaviour", Pearson Education Inc., 13 edition, 2010.
	REFERENCE BOOKS
	1. Joseph J, Massie, "Essentials of Management" Prentice Hall of India Pvt. Ltd. 1985. 2. Ties, AF, Stoner and R.Edward Freeman, "Management" Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992 3. Tripathi. P.C. & P.N. Reddy, "Principles of Management", Tata McGraw Hill, 2006.
COURSE OUTCOMES **Upon completion of the course, students will be able to**	
CO1	Know about Evolution of Modern Management and Forms of Organization.
CO2	Understand the need for planning and controlling activities in the organisation
CO3	Learn about the individuals and group behaviours in the organisation
CO4	Know about the effect Leadership roles and Organizational Structures
CO5	Understand the different modern concepts to evaluate the management activities.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	1	2	2	2	1	1	2	1	3	2	-	-	1	1
CO2	3	3	2	3	2	2	2	2	3	1	3	2	-	-	1	2
CO3	3	3	3	3	3	3	2	2	3	1	3	2	-	-	1	2
CO4	3	3	2	3	3	2	2	2	2	1	3	2	-	-	1	2
CO5	3	3	1	2	2	2	2	2	2	1	3	2	-	-	1	3

MANDATORY COURSES

MX4001	INTRODUCTION TO WOMEN AND GENDER STUDIES	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

OBJECTIVES

- To enhance social sensitivity, sensibility and responsibility thereby instilling the life skills among students, through applied learning.
- To upgrade knowledge and comprehension of gender issues for attitudinal and behavioural changes among marginalized groups to claim the right to life with dignity and equality through extension and collaborative activities.
- To evolve inclusive approach for holistic development in order to promote women empowerment

UNIT I	INTRODUCTION TO WOMEN'S STUDIES	9
Key concepts in Gender studies - Need, Scope and challenges of Women's Studies – Women's Studies as an academic discipline - Women's Studies to Gender Studies - Need for Gender Sensitization - Women's Movements – global and local: Pre-independence - Post-independence and Contemporary Debates - National Committees and Commissions for Women.		
UNIT II	**FEMINIST THINKERS AND THEORIES**	**9**
Liberal Feminism - Marxist Feminism - Radical Feminism - Socialist Feminism - Indian Feminism - Black Feminism - Eco-Feminism - New Feminist Debates- Post Colonial /Post Modern - Masculinity Studies - Contemporary Contestations – Intersex and Transgender Movements. Feminist thinkers in 18^{th}, 19^{th}, 20h and 21^{st} Century.		
UNIT III	**GENDER AND EDUCATION**	**9**
Women's Education – Gender diversities and disparities in enrolment, Curriculum content, Dropouts, profession and Gender - Gendered Education- Family, Culture, Gender roles, Gender Identities -Education for the Marginalized Women - Recent Trends in Women's Education – Committees and Commissions on Education - Vocational education and skill Development for women.		
UNIT IV	**WOMEN, WORK AND EMPLOYMENT**	**9**
Theoretical Perspective: Fredrick Engels, Rosa Luxemburg, Sandra Whiteworth, Boserup Esther -Concept of Work – Productive and non – productive work – Use value and market value - Gender Division of Labour – Mode of Production – Women in organized andunorganized sector - New Economic Policy and its impact on Women's Employment – Globalization –Structural Adjustment Programs.		
UNIT V	**GENDER AND ENTREPRENEURSHIP**	**9**
Concept and meaning, Importance of Entrepreneurship, Entrepreneurial traits, Factors contributing to Entrepreneurship, enabling environment, small Enterprises, women in agri-business - Gender and emerging Technology – Impact - Self-help Groups and Micro Credit - Gender mainstreaming, Gender budgeting, planning and Analysis.		
		Total Hours: 45

TEXT BOOKS

1. Jaya Kothari Pillai- 1995, Women and Empowerment, New Delhi: Gyan Publishing House

2. JoRoland–: 1997, Questioning Empowerment, Oxfam Oxford.

3. Janet Townsend etal-: 1999, Women and Power, Fighting Patriarchy and Poverty. Zed Books, London.

4. Naila Kabeer: 1996, Reversed Realities, Kali for women, New Delhi.

COURSE OUTCOMES Upon completion of the course, students will be able to	
CO1	To enhance the social sensitivity, sensibility and responsibility thereby instilling the life skills among students.
CO2	To upgrade knowledge and comprehension of gender issues for attitudinal and behavioural change among men, women and transgender etc. to claim the right to life with dignity and equality.
CO3	To bring social, economic, political and cultural empowerment and gender equality in personal as well Professional life.
CO4	To crystallize the teaching of Women's Studies in term of teaching, research and extension. in order
CO5	To create more gender equality and equity world by education, sensitization and empowerment.

	MAPPING OF COs WITH POs AND PSOs															
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	1	1	1	1	-	-	1	-	-	-	2
CO2	-	-	-	-	-	1	1	1	1	-	-	1	-	-	-	2
CO3	-	-	-	-	-	1	1	1	1	-	-	1	-	-	-	2
CO4	-	-	-	-	-	1	1	1	1	-	-	1	-	-	-	2
CO5	-	-	-	-	-	1	1	1	1	-	-	1	-	-	-	2

MX4002	**ELEMENTS OF LITERATURE**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

OBJECTIVES

- To understand the recent contexts, concepts and ideologies.
- To acquaint themselves with the major generic divisions in English literature.
- To acknowledge the conventions of literary research and documentation.

UNIT I	**KEY ELEMENTS OF LITERATURE**	**9**
Language - Plot - Setting/Milieu - Character - Theme - Point of View - Tone/Mood.		
UNIT II	**PROSE**	**9**
The form of prose - written and spoken prose - individual and common style - simplicity and ornamentation - abstract and concrete - realism, romance and unreality - the science of rhetoric.		
UNIT III	**POETRY**	**9**
The importance of form - the physical form of poetry - metre - variation - rhyme - internal pattern - logical sequence - the use of associations - patterns of imagery the main types of poetry.		
UNIT IV	**NOVEL**	**9**

The concept of fiction - verisimilitude - the point of view - plot - character - character revealed - conversation - scene and background - dominant themes - the experimental novel.		
UNIT V	**DRAMA**	**9**
Live literature - action - plots - conventional divisions - direct experience of characters - dialogue and conversation - verse and prose - types of drama - drama and history - use of notes – interpretation.		
		Total Hours: 45

TEXT BOOKS

1. Barnet Sylvan, Types of Drama; Plays and Essays, Boston, Little Brown, 1981.
2. Brooks, Peter, Reading for the Plot; Design and Intention in Narrative, Oxford, Clarendon Press, 1984.
3. Hardings D.W., Words Into Rhythm; English Speech, OUP, New Delhi, 1976.
4. Murfin, Ross, and Supriya M. Ray. The Bedford Glossary of Critical and Literary Terms. New York: Macmillan Press Ltd., 1997.
5. Paul, Poplawski, ed. English Literature in Context. London: CUP,2008.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Comprehend various forms of literature like prose, poetry, drama and fiction.
CO2	Interpret and appreciate the didactic purpose in literature.
CO3	Identify the poetic devices to the connection of poems.
CO4	Describe the process and origin of the development of drama in its structure with the text.
CO5	Define the various types of novels with their structure

	MAPPING OF COs WITH POs AND PSOs															
COs	**PROGRAM OUTCOMES (POs)**												**PROGRAM SPECIFIC OUTCOMES (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	1	-	1	-	1	-	1	-	-	-	1
CO3	-	-	-	-	-	1	-	1	-	1	-	1	-	-	-	1
CO4	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1
CO5	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1

MX4003	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

OBJECTIVES

- To develop inter personal skills and be an effective goal-oriented team player.
- To develop professionals with idealistic, practical and moral values.
- To develop communication and problem-solving skills.
- To re-engineer attitude and understand its influence on behavior

UNIT I	**9**
Neetisatakam-Holistic development of personality I Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue)	
UNIT II	**9**
Neetisatakam-Holistic development of personality II Verses- 52,53,59 (don'ts), Verses- 71,73,75,78 (do's)	
UNIT III	**9**
Approach to day-to-day work and duties. Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.	
UNIT IV	**9**
Statements of basic knowledge. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68, Chapter 12 -Verses 13, 14, 15, 16,17, 18	
UNIT V	**9**
Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39, Chapter18 – Verses 37,38,63.	

TEXT BOOKS

1. "Srimad Bhagavad Gita" by Swami Swarupananda, Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Study of Shrimad Bhagwad Geeta will help the student in developing his personality and achieve the highest goal in life.
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
CO3	Study of Neetishatakam will help in developing versatile personality.
CO4	Issues basic knowledge to the students from gita
CO5	Develop personality role model

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFIC OUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1
CO3	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1
CO4	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1

MX4004	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
	Common to all Branches	3	0	0	0

OBJECTIVES

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I	**INTRODUCTION TO DISASTERS**	**9**
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters..		**CO1**
UNIT II	**APPROACHES TO DISASTER RISK REDUCTION (DRR)**	**9**
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.		**CO2**
UNIT III	**INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT**	**9**
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.		**CO3**
UNIT IV	**DISASTER RISK MANAGEMENT IN INDIA**	**9**
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment		**CO4**

UNIT V	DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS	9
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.		**CO5**
		TOTAL: 45 HOURS

	TEXTBOOKS
	1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423 2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361] 3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011 4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, Newdelhi, 2010.
	REFERENCE BOOKS
	1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005 2. Government of India, National Disaster Management Policy,2009.

COURSE OUTCOMES
Upon completion of the course, students will be able to

CO1	Differentiate the types of disasters, causes and their impact on environment and society
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation
CO3	Draw the hazard and vulnerability profile of India, Scenarios in the Indian context,
CO4	Know about the relief measures, Disaster damage assessment and management.
CO5	Learn through case studies about the damages caused due to various disasters.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFIC OUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	1	-	-	3	3	-	-	-	-	2	-	-	-	2
CO2	-	-	1	-	-	3	3	-	-	-	-	2	-	-	-	2
CO3	-	-	1	-	-	3	3	-	-	-	-	2	-	-	-	2
CO4	-	-	1	-	-	3	3	-	-	-	-	2	-	-	-	2
CO5	-	-	2	-	-	3	3	-	-	-	-	2	-	-	-	2

MX4005	**WELL BEING WITH TRADITIONAL PRACTICES**	**L**	**T**	P	**C**
		3	0	0	0

OBJECTIVES

- Explaining the purpose of well being and impact it has on their work and life
- To teach basic methods used in the systems of Ayurveda, Siddha and Yoga
- Identify key factors that contribute to work place burnout and sustainability.

Unit1	**HEALTH AND HAPPINESS**	**9**
Mental and physical health, physical and emotional safety, and a feeling of belonging, sense of purpose, achievement and success.Need for Managing Self, Positive Psychology and Yoga.		**CO1**
Unit 2	**WELL BEING**	**9**
Health and Wellbeing: Perspectives from Positive Psychology, Yoga and Ayurveda, Attaining Wellbeing – Methods, Obstacles, Realms and Types of Interventions for Managing Self and Career		**CO2**
Unit 3	**YOGA PRACTICES**	**9**
Definitions of Eight parts of yoga.(Ashtanga). Asan and Pranayam - Various yoga poses and their benefits for mind & body - Regularization of breathing techniques and its effects- Types of pranayam		**CO3**
Unit 4	**AYURVEDA PRACTICS**	**9**
Health Benefits of Ayurveda, Ayurvedic techniques: Diet, Herbal, Acupuncture, Massage and Meditation. Ayurveda and allied disciplines –Approach to health disease in Ayurveda		**CO4**
Unit 5	**BASIC CONCEPTS AND PRINCIPLES OF SIDDHA MEDICINE**	**9**
Principles of Siddha- the five natural elements and three humours, Physical constituents.		**CO5**
	TOTAL: 45 HOURS	

TEXT BOOKS

1. Mental health and well being in workplace by Gillhassan and Donna Butler.
2. Yogic Asanas for Group Training - Part- I": Janardan Swami Yogabhyasi Mandal, Nagpur.
3. Textbook of Ayurveda: Volume 1 - Fundamental Principles of Ayurveda by Dr Vasant Lad.
4. *Siddha medicine handbook of raditional remedies by* Paul Joseph

REFERENCE BOOKS

1. The Social Psychology of Mental Health: Basic Mechanisms and Applications by Diane N Ruble
2. "Raja yoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama Publication Department), Kolkata.

COURSE OUTCOME

CO1	To create awareness about health and happiness
CO2	To develop healthy mind in a healthy body thus improving social health also
CO3	To educate the importance of various yoga asanas
CO4	To know the values of ayurveda system
CO5	To understand the importance of siddha medicine.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**											**PROGRAMME SPECIFIC OUTCOMES**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	2	-	-	2	2	2	-	-	-	2	-	-	-	2
CO2	-	-	2	-	-	2	2	2	-	-	-	2	-	-	-	2
CO3	-	-	2	-	-	2	2	3	-	-	-	2	-	-	-	2
CO4	-	-	1	-	-	2	3	3	-	-	-	2	-	-	-	2
CO5	-	-	1	-	-	2	2	2	-	-	-	2	-	-	-	2

MX4006	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P		C
		3	0	0		0

OBJECTIVES

- To provide an exposure to the development of science and technology in India
- To impart authentic knowledge of India's scientific and technological traditions.
- To provide an understanding of the socio-cultural and philosophical context in which science and technology developed.
- To help in repositioning India's contributions in science and technology

Unit1	**Introduction**	**9**
Logic and methodology of Indian sciences - An overview of Indian contributions to sciences - An overview of Indian contributions to technology		**CO1**
Unit 2	**Astronomy**	**9**
Development of astronomy in India- Pancanga: Indian calendrical computations- The distinctfeatures of Indian planetary models- Computation of eclipses: Its simplicity-elegance and efficiency- Observational astronomy in India		**CO2**
Unit 3	**Mathematics**	**9**
An overview of the development of mathematics in India – Mathematics contained in Sulbasutras – combinatorial aspects of the Chandassastra – Solutions to the first and second order indeterminate equations- Weaving mathematics into beautiful poetry: Bhaskaracarya – The evolution of sine function in India – The discovery of calculus by Kerala astronomers.		**CO3**
Unit 4	**Ayurveda**	**9**
History of Ayurveda – Rational foundations of Ayurveda – Textual sources in Ayurveda – Ayurveda and allied disciplines –Approach to health disease in Ayurveda – Approach to diet and nutrition in Ayurveda – Ayurveda and modern medicine – Ayurveda and Yoga		**CO4**
Unit 5	**Technological development in India**	**9**
Agriculture: Origin and development- Ancient crops- Traditional practices Water management: Overview- Harappan water management- Other case studies- Medieval Water structures Pottery: Overview- Technical aspects Silpasastra: Architecture and Construction: An introduction to Silpasastra- Construction Technology Metallurgy: Copper/Bronze/Zinc- Iron and Steel Technology in India		**CO5**

	TOTAL: 45HOURS
	TEXT BOOKS
1	Suvobrata Sarkar, History of Science, Technology, Environment, and Medicine in India, Taylor & Francis, London
2	NeeraMisra, Sabareesh P.a. 2022, A Brief History of Science in India, Garuda Prakashan Private Limited.
3	Prittam Dutta 2021, WHAT IS ASTRONOMY ?, Notion Press
	REFERENCE BOOKS
1	D. P. Chatpathayaya, History of science, philosophy, and culture in India civilization, Uma das Gupta, Pearson Education.
2	Bryan Bunch, Bryan H. Bunch, Alexander Hellemans, The History of Science and Technology, Houghton Mifflin.

3	Projit Bihari Mukharji · 2016, Doctoring Traditions-Ayurveda, Small Technologies, and Braided Sciences, University of Chicago Press
	COURSE OUTCOME
CO1	Gain knowledge on Indian sciences
CO2	Able to understand the evolution of stars as well as of the large scale structure of the Universe
CO3	Can use to solve problems involved in arithmetic, algebra, geometry, and other fields of mathematics
CO4	Helps in understanding each individual at a very subtle, personal level and gives a detailed protocol for diet, daily routines and activities to be followed.
CO5	Gain knowledge on origin of agriculture, technical aspects of pottery and silpasastra

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS O1**	**PS O2**	**PS O3**	**PS O4**
CO1	-	-	-	1	-	-	2	2	-	-	-	2	-	-	1	1
CO2	2	2	1	1	1	2	2	1	-	-	1	3	-	-	-	1
CO3	3	3	2	1	1	-	-	-	1	-	1	2	-	-	1	1
CO4	1	-	-	-	-	3	3	1	-	-	-	3	-	-	-	1
CO5	2	2	1	1	2	3	3	1	-	-	-	2	-	-	-	1

MX4007	**POLICAL AND ECONOMIC THOUGHT FOR HUMAN SOCIETY**	**L**	**P**	**T**	**C**
		3	0	0	3

OBJECTIVES

- To understand the concept of political science and theories of political science.
- To know the types of political socialization and their role.
- To explore various theories of economic thought.
- To learn the importance of human values of life.

UNIT I	**POLITICAL THOUGHTS**	**9**
Political science: Definition, Nature & Scope; Relation of Political Science with other Social Sciences; Traditional approaches to the study of Political Science: Normative, Empirical and Feminist-State: Definition; Elements; Relation with other organizations; Theories of origin of state (Theory of Divine, Force, and Evolutionary); Sovereignty- definition and characteristics.		**CO1**
UNIT II	**POLITICAL CULTURE AND POLITICAL SOCIALIZATION**	9
Meaning and dimensions of political culture, meaning and types of political socialization agencies of political socialization and their role-Meaning and types of political participation,		CO2

political apathy – reasons for political apathy, Determinants of political participation – psychological, social and political.		
UNIT III	**HISTORY OF ECONOMIC THOUGHT**	9
Nature and Importance of Economic thought – Approaches of Economic Thought – Scholastics – Mercantilism, French and English – Thomas Munn – Scientific Method and the French Physiocrats – Quesnay – The Classical School – Adam Smith – Division of Labour – Ricardo and Theory of Rent – Comparative Cost Theory – Stationary State – Malthus and Theory of Population and Theory of Gluts.		CO3
UNIT IV	**ECONOMIC BEHAVIOUR AND MORAL SENTIMENTS**	9
Importance of ethics in economics; Outcomes of ethical analysis; Duties, rules and virtues; Economic behaviour: Self-interest and rational behaviour- Adam Smith and self-interest - Social Philosophy (Naturalism, Optimism, Self Interest, Invisible hand, Laisseze faire); Economic ideas: Wealth, Labour & Division of labour, Value, Distribution.		CO4
UNIT V	**HUMAN VALUES**	9
Value Education, Self-Exploration - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship - the basic requirements for fulfillment of aspirations of every human being with their correct priority, Method to fulfill the human Values, understanding and living in harmony at various levels.		CO5
TOTAL : 45 HOURS		

TEXT BOOKS

1. Bhargava, R. (2008) 'What is Political Theory', in Bhargava, R and Acharya, A. (eds.) Political Theory: An Introduction. New Delhi: Pearson Longman.
2. Olivier Blanchard and David R. Johnson, Macroeconomics, Sixth Edition, Pearson, 2017.
3. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

REFERENCE BOOKS

1. O.P.Gauba, (2015) An Introduction to Political Theory, New Delhi: Mayur Publishers.
2. Ashaf, Ali and Sharma B.N. 2001.Political Sociology, University Press, Hyderabad .
3. Jonathan Conlin, Great Economic Thinkers: From Adam Smith to Amartya Sen, Speaking Tiger Publishing, 2018.
4. Linda Yueh, The Great Economists: How Their Ideas Can Help Us Today, Viking, 2018.
5. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Book.
6. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. Irene van Staveren, The Values of Economics: An Aristotelian Perspective, London: Routledge, 2001

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	To explain the traditional approached of political science and theories of state.
CO2	To identify the political culture, socialization, participation and apathy.
CO3	To understand the importance of economic thought and their approaches.
CO4	To explore the economic behaviour and moral sentiments of the individuals.
CO5	To learn the human values for harmony and to build better relationships.

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1	1	3	1	1	1	1	2	2	1	2	-	-	1	3
CO2	1	1	1	3	1	2	1	1	2	2	1	2	-	-	1	3
CO3	1	2	1	3	1	2	1	2	2	2	1	2	-	-	1	3
CO4	1	2	2	3	1	2	3	2	2	3	1	2	-	-	2	3
CO5	1	2	1	3	1	1	3	3	3	3	1	2	-	-	1	3

MX4008	**INDUSTRIAL SAFETY**	**L**	**T**	**P**	**C**
	Common to all Branches	3	0	0	0

OBJECTIVE

- To impart knowledge on safety engineering fundamentals and safety management practices..

UNIT I	**INTRODUCTION**	**9**
Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.		**CO1**
UNIT II	**CHEMICAL HAZARDS**	**9**
Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.		**CO2**
UNIT III	**ENVIRONMENTAL CONTROL**	**9**
Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.		**CO3**
UNIT IV	**HAZARD ANALYSIS**	**9**
System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment		**CO4**
UNIT V	**INDUSTRIAL SAFETY**	**9**
Explosions – Disaster management – catastrophe control, hazard control, Safety education and training - Factories Act, Safety regulations Product safety – case studies.		**CO5**
		TOTAL: 45 HOURS

	TEXTBOOKS
1	John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.
	REFERENCE BOOKS
1	Safety Manual, "EDEL Engineering Consultancy", 2000.
2	David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Understand the modern safety concepts and Mechanical hazards
CO2	Identify the effects of Chemical exposure and Toxic materials
CO3	Understand the Industrial Health Hazards due to environment
CO4	Understand the System Safety Analysis Techniques
CO5	Understand the Factories Act, Safety regulations

	MAPPING BETWEEN CO AND PO, PSO WITH CORRELATION LEVEL 1/2/3															
COs	**PROGRAMME OUTCOMES**												**PROGRAMME SPECIFIC OUTCOMES**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	2	-	-	3	2	2	-	-	-	3	-	-	1	2
CO2	-	-	2	-	-	3	2	2	-	-	-	2	-	-	1	2
CO3	-	-	2	-	-	3	2	2	-	-	-	2	-	-	1	2
CO4	-	-	2	-	-	3	2	2	-	-	-	3	-	-	1	2
CO5	-	-	2	-	-	3	2	2	-	-	-	3	-	-	2	2

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a professional elective from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
Complete details are available in clause 4.10 of Regulations 2022.

PROFESSIONAL ELECTIVES / VERTICALS FOR MINOR DEGREE
(In addition to all the Professional Electives / verticals of other programmes)

Vertical I Fintech and Block	**Vertical II Entrepreneursh ip**	**Vertical III Public Administratio**	**Vertical IV Business Data Analytics**	**Vertical V Environment and**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmenta
Banking, Financial Services and	Creativity & Innovation in Entrepreneurshi	Public Personnel Administration	Human Resourc e Analytic	Sustainable Bio Materials
Introduction to Blockchain and its	Principles of Marketing Management For	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation and Supply Chain	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable