RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM

VISION

To produce globally competent Electronics and Communication Engineers with a commitment to serve the society.

MISSION

M1 To impart training with the best of teaching expertise supported by excellent laboratory infrastructure and exposure to recent trends in the industry.

M2 To ensure that the students are molded into competent Electronics and Communication engineers with the knowledge of computer applications and worthy citizens of the country.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO I

To provide students with sound foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, analyze and solve engineering problems and to prepare them for post graduate studies and for successful careers in industries.

PEO II

To develop the ability among students to define engineering problems in the fields of electronics and Communication engineering, and to employ necessary techniques, hardware, and communication tools for modern Engineering applications.

PEO III

To instil the values, skills, leadership and team spirit for comprehensive and wholesome personality, to promote entrepreneurial interest among students and to create a fervor for use of Engineering in addressing societal concerns.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and

an engineering specialization to the solution of complex engineering problems.

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

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

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

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

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

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

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

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

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

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

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to formulate solutions for practical societal requirements using communication engineering.

PSO2: To design and formulate solutions for industrial requirements using Electronics and Communication engineering.

PSO3: To understand and develop solutions required in multidisciplinary engineering fields.

RAJALAKSHMI ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY)

B.E ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATIONS – 2019 (REVISED)

CHOICE BASED CREDIT SYSTEM

CURRICULUM

SEMESTER I								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	HS19151	Technical English	HS	3	2	1	0	3
2	MA19152	Linear Algebra and Applied Calculus	BS	4	3	1	0	4
3	CY19142	Chemistry for Electronics Engineering	BS	5	3	0	2	4
4	GE19141	Programming using C	ES	6	2	0	4	4
5	MC19102	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
PRACTICALS								
6	GE19122	Engineering Practices -Electrical and Electronics	ES	2	0	0	2	1
			TOTAL	**23**	**13**	**2**	**8**	**16**

SEMESTER II								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	MA19252	Differential Equations and Complex Variables	BS	4	3	1	0	4
2	PH19242	Physics for Electronics Engineering	BS	5	3	0	2	4
3	GE19101	Engineering Graphics	ES	4	2	2	0	4
4	CS19241	Data Structures	ES	7	3	0	4	5
5	EC19241	Electron Devices	PC	5	3	0	2	4
6	MC19101	Environmental Science and Engineering	MC	3	3	0	0	0
PRACTICALS								
7	GE19121	Engineering Practices- Civil and Mechanical	ES	2	0	0	2	1
			TOTAL	**30**	**17**	**3**	**10**	**22**

SEMESTER III								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	MA19352	Transforms and Special Functions	BS	4	3	1	0	4
2	EE19241	Basic Electrical Engineering	ES	5	3	0	2	4
3	EC19301	Analog Circuits -I	PC	3	3	0	0	3
4	EC19302	Digital Electronics	PC	3	3	0	0	3
5	EC19303	Signals and Systems	PC	3	3	0	0	3
6	MC19301	Essence of Indian Traditional knowledge	MC	3	3	0	0	0
PRACTICALS								
7	EC19311	Analog and Digital Circuits Laboratory	PC	4	0	0	4	2
8	GE19211	Problem solving and programming in Python	ES	5	1	0	4	3
			TOTAL	**30**	**19**	**1**	**10**	**22**

SEMESTER IV								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	MA19452	Probability and Random Processes	BS	4	3	1	0	4
2	EC19401	Microprocessors and Microcontrollers	PC	3	3	0	0	3
3	EC19402	Communication Theory	PC	3	3	0	0	3
4	EC19441	Analog Circuits-II	PC	5	3	0	2	4
5		Open Elective-I	OE	6	0	0	6	3
PRACTICALS								
6	EC19411	Microprocessors and Microcontrollers Laboratory	PC	4	0	0	4	2
7	GE19421	Soft Skills-I	EEC	2	0	0	2	1
8	CS19411	Python programming for Machine Learning	ES	5	1	0	4	3
			TOTAL	**32**	**13**	**1**	**18**	**23**

SEMESTER V								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	EC19501	Digital Signal Processing	PC	3	2	1	0	3
2	EC19502	Control System Engineering	PC	3	2	1	0	3
3	EC19503	EM Waves and Waveguides	PC	3	2	1	0	3
4	EC19504	Digital Communication	PC	3	3	0	0	3
5		Professional Elective-I	PE	3	3	0	0	3
6		Professional Elective-II	PE	3	3	0	0	3
PRACTICALS								
7	EC19511	Digital Signal Processing Laboratory	PC	4	0	0	4	2
8	EC19512	Communication Systems Laboratory	PC	4	0	0	4	2
9	GE19521	Soft Skills-II	EEC	2	0	0	2	1
			TOTAL	**28**	**15**	**3**	**10**	**23**

SEMESTER VI								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	EC19601	Antenna Theory	PC	3	3	0	0	3
2	EC19602	Wireless Communication	PC	3	3	0	0	3
3	EC19641	VLSI Design	PC	5	3	0	2	4
4	EC19642	Communication Networks	PC	5	3	0	2	4
5		Open Elective-II	OE	6	0	0	6	3
PRACTICALS								
6	GE19621	Problem Solving Techniques	EEC	2	0	0	2	1
7	GE19612	Professional Readiness for Innovation, Employability and Entrepreneurship	EEC	6	0	0	6	3
8	EC19603	Problem Solving using AI and ML Techniques (Mini Project)	EEC	4	0	0	4	2
			TOTAL	**34**	**12**	**0**	**22**	**23**
SEMESTER VII								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	EC19701	RF and Microwave Engineering	PC	3	3	0	0	3
2	EC19702	Optical Communication and Networks	PC	3	3	0	0	3
3	EC19703	Embedded Systems	PC	3	3	0	0	3
4		Professional Elective-III	PE	3	3	0	0	3
5		Professional Elective- IV	PE	3	3	0	0	3
PRACTICALS								
6	EC19711	Embedded Laboratory	PC	4	0	0	4	2
7	EC19712	Advanced Communication Systems Laboratory	PC	4	0	0	4	2
			TOTAL	**23**	**15**	**0**	**8**	**19**
SEMESTER VIII								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1		Professional Elective-V	PE	3	3	0	0	3
2		Professional Elective-VI	PE	3	3	0	0	3
PRACTICALS								
3	EC19811	Project work	EEC	20	0	0	20	10
			TOTAL	**26**	**6**	**0**	**20**	**16**
			TOTAL NUMBER OF CREDITS:	**164**				

PROFESSIONAL ELECTIVES (PE)

SEMESTER V								
PROFESSIONAL ELECTIVE-I								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	CS19301	Computer Architecture	PE	3	3	0	0	3
2	EC19P51	Introduction to Avionics	PE	3	3	0	0	3
3	EC19P52	Information Theory and coding	PE	3	3	0	0	3
4	EC19P53	Introduction to MEMS	PE	3	3	0	0	3
5	EC19P54	Nano Electronics	PE	3	3	0	0	3
6	CR19P61	Micro Fabrication Laboratory	PE	2	0	0	2	1
PROFESSIONAL ELECTIVE II								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	EC19P55	Speech and Audio processing	PE	3	3	0	0	3
2	EC19P56	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3
3	EC19P57	Biomedical Electronics	PE	3	3	0	0	3
4	GE19304	Fundamentals of Management for Engineers	PE	3	3	0	0	3
5	GE19401	Fundamentals of Mechanics	PE	3	3	0	0	3
6	CR19P62	Microfluidics Laboratory	PE	2	0	0	2	1
SEMESTER VII								
PROFESSIONAL ELECTIVE III								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	EC19P71	Cognitive Radio	PE	3	3	0	0	3
2	EC19P72	Digital Image Processing	PE	3	3	0	0	3
3	MT19P76	Robotics and Machine Vision	PE	3	3	0	0	3
4	EC19P73	Mixed signal IC Design	PE	3	3	0	0	3
5	CR19P63	Texas Instruments – Robotics System Laboratory	PE	2	0	0	2	1
PROFESSIONAL ELECTIVE IV								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	EC19P74	Wireless Networks	PE	3	3	0	0	3
2	EC19P75	Adaptive Signal processing	PE	3	3	0	0	3
3	EC19P76	Multimedia Compression and Networking	PE	3	3	0	0	3

4	EC19P77	Comprehensive Course on ECE	PE	3	3	0	0	3
SEMESTER VIII								
PROFESSIONAL ELECTIVE V								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	EC19P81	Artificial Intelligence and Neural Networks	PE	3	3	0	0	3
2	EC19P82	Essentials of Cryptography and Network security	PE	3	3	0	0	3
3	EC19P83	Introduction to IoT	PE	3	3	0	0	3
4	EC19P84	Wavelets	PE	3	3	0	0	3
PROFESSIONAL ELECTIVE VI								
S.NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1	EC19P85	Wireless Sensor Networks	PE	3	3	0	0	3
2	EC19P86	Radar and Navigational Aids	PE	3	3	0	0	3
3	EC19P87	Machine Learning and Deep Learning	PE	3	3	0	0	3
4	EC19P88	Satellite Communication	PE	3	3	0	0	3

B.E ELECTRONICS AND COMMUNICATION ENGINEERING
CREDITS DISTRIBUTION

S. NO	COURSE CATEGORY	CREDITS PER SEMESTER								TOTAL CREDITS	
		1	2	3	4	5	6	7	8	PROPOSED CURRICULUM	AICTE
1	HS	3								3	13
2	BS	8	8	4	4					24	23
3	ES	5	10	7	3					25	23
4	PC		4	11	12	16	14	13		70	51
5	PE					6		6	6	18	21
6	OE				3		3			6	15
7	GE									0	-
8	EEC				1	1	6		10	18	14
9	MC	*	*	*						Non credits	Non credits
	Total	**16**	**22**	**22**	**23**	**23**	**23**	**19**	**16**	**164**	**160**

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CHOICE BASED CREDIT SYSTEM

SEMESTER I

Subject Code	Subject Name	Category	L	T	P	C
HS19151	**TECHNICAL ENGLISH** **Common to all branches of B.E./ B.Tech programmes – I semester**	HS	**2**	**1**	**0**	**3**

Objectives: The student should be made

- To enable learners to acquire basic proficiency in English reading and listening.
- To write in English precisely and effectively
- To speak flawlessly in all kinds of communicative contexts

UNIT-I	**VOCABULARY BUILDING**	**9**

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II	**BASIC WRITING SKILLS**	**9**

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.

UNIT-III	**GRAMMAR AND LANGUAGE DEVELOPMENT**	**9**

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc.).

UNIT-IV	**WRITING FOR FORMAL PRESENTATION**	**9**

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking**- Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V	**EXTENDED WRITING AND SPEAKING**	**9**

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course, students will be able to

- Discuss and respond to the listening content
- Read and comprehend different texts and appreciate them
- Understand structures and techniques of precise writing
- Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures
- Write and speak appropriately in varied formal and informal contexts

Text Books:

1. English for Technologists & Engineers, Orient BlackSwan Publications, Chennai 2012.

Reference Books / Web links:

1. Technical Communication, Meenakshi Raman &Sangeeta Sharma, Oxford University Press.

2	Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi.
3	Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press.
4	Practical English Usage. Michael Swan. OUP. 1995.
5	Remedial English Grammar. F.T. Wood. Macmillan.2007
6	On Writing Well. William Zinsser. Harper Resource Book, 2001.
7	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS19151.1	1	-	-	-	-	-	1	-	2	3	1	3	-	-	-
HS19151.2	-	3	-	2	-	-	-	-	-	2	1	1	-	-	1
HS19151.3	-	-	-	1	-	-	-	-	-	3	-	-	-	-	1
HS19151.4	-	1	-	1	-	-	-	-	-	3	-	2	-	-	1
HS19151.5	1	1	1	1	1	1	1	1	2	3	1	1	1	-	1
Average	0.4	1	0.2	1	0.2	0.2	0.4	0.2	0.8	2.8	0.6	1.2	0.2	-	0.8

Subject Code	Subject Name	Category	L	T	P	C
MA19152	**LINEAR ALGEBRA AND APPLIED CALCULUS** **Common to I sem. B.E.- Computer Science and Engineering, Biomedical Engineering, Electronics and Communication Engineering & Electrical and Electronics Engineering** **and** **B.Tech. – Information Technology**	BS	3	1	0	4

Objectives: The student should be made

- To gain knowledge in using matrix algebra techniques and the concepts of basis and dimension in vector spaces
- To understand the techniques of calculus which are applied in the Engineering problems

UNIT-I	MATRICES	12

Symmetric and skew – symmetric matrices, orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT-II	VECTOR SPACES	12

Vector space – Linear dependence and independence of vectors, bases, dimensions - range and kernel of a linear map, rank and nullity – matrix of Linear transformation - inverse of a linear transformation - rank nullity theorem – composition of Linear maps – Matrix Associated with Linear Map - inner products and norms – Gram – Schmidt orthogonalization.

UNIT-III	DIFFERENTIAL CALCULUS AND APPLICATIONS	12

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes and Envelopes - Partial derivatives: Definitions and Simple problems - Jacobian and properties – Taylor's series for functions of two variables – Lagrange's method of undetermined multipliers.

UNIT-IV	APPLICATION OF INTEGRATION AND IMPROPER INTEGRALS	12

Evaluation of area, surface area and volume of revolution - Centre of Gravity – Moment of inertia – Improper integrals: Beta and Gamma integrals and their properties.

UNIT-V	MULTIPLE INTEGRAL	12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

Total Contact Hours	:	60

Course Outcomes: On completion of the course students will be able to

- Apply the concept of Eigen values and eigenvectors, diagonalization of a matrix for solving problems
- Use concepts of basis and dimension in vector spaces in solving problems and to construct orthonormal basis using inner products
- Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima
- Apply the techniques of Integration in Engineering problems
- Evaluate surface area and volume using multiple integrals

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Linear Algebra and Partial Differential Equations, McGraw Hill Education,2019.

Reference Books / Web links:

1. Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Friedberg, A.H., Insel, A.J. and Spence, L., ―Linear Algebra‖, Prentice - Hall of India, New Delhi, 2004.
3. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5. T Veerarajan, Engineering Mathematics –I, McGraw Hill Education, 2018.
6. T Veerarajan, Engineering Mathematics –II, McGraw Hill Education, 2018.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19152.1	3	3	3	3	3	1	-	-	-	-	2	2	2	3	3
MA19152.2	3	3	3	3	2	1	-	-	-	-	-	2	2	3	3
MA19152.3	3	3	3	3	3	1	1	-	-	-	2	3	1	2	1
MA19152.4	3	3	3	3	3	1	1	-	-	-	1	3	1	2	1
MA19152.5	3	3	3	3	2	1	-	-	-	-	1	3	1	2	1
Average	3	3	3	3	2.6	1	1	-	-	-	1.5	2.6	1.4	2.4	1.8

Subject Code	Subject Name	Category	L	T	P	C
CY19142	CHEMISTRY FOR ELECTRONICS ENGINEERING Common to I sem. B.E. – Electronics and Communication Engineering and II sem. B.E. - Biomedical Engineering	BS	3	0	2	4

Objectives: The student should be made	
●	To understand the principles of electrochemical processes and corrosion control
●	To get familiarised with the functioning batteries of and fuel cells
●	To acquire knowledge on polymeric, ceramic and nanomaterials used in electronic and medical industry

UNIT-I	ELECTROCHEMISTRY	9
Electrode potential – Electrodes– standard and reference electrodes, glass electrode. Nernst equation, emf series–applications. Galvanic and concentration cells. -applications - pH measurement, acid- base titration-potentiometric redox titration-conductometric titrations - potentiometric sensors -chemical bio signals- glucose sensor, gas sensor- blood oxygen level.		
UNIT-II	CORROSION AND ELECTROCHEMICAL PROCESSES	9
Cause and effects of corrosion – theories of chemical and electrochemical corrosion – types of corrosion: galvanic, stress, intergranular corrosion and pitting corrosion –factors affecting rate of corrosion. Electroplating (copper)-electroless plating (Nickel) - electropolishing, electrochemical machining- electrochemical etching - surface preparation – etching – drying -electrochemical etching of Cu from PCB - electrophoretic painting.		
UNIT-III	BATTERIES AND FUEL CELLS	9
Batteries- types - battery characteristics-fabrication and working of lead- acid battery- NICAD - lithium-ion batteries – supercapacitors – introduction – types – electrochemical double layer capacitor – activated carbon – carbon aerogels - Fuel cells – classification – principle – components - applications of hydrogen-oxygen fuel cell, solid oxide fuel cell, direct methanol, proton exchange membrane fuel cells and biofuel cells.		
UNIT-IV	ADVANCED MATERIALS	9
Introduction to thermoplastics and thermosetting plastics- preparation and applications of polypropylene (PP), polyvinylchloride (PVC), polyurethanes, polyamide (Nylon 6,6), polyacrylates (PAN), silicone rubber, Biodegradable polymers (PGA and PLA) - conducting polymers – introduction and examples- polyaniline Metallic and ceramic implant materials: Composition, properties and applications of stainless steel, titanium-based alloys, cobalt – chromium alloys- ceramics – hydroxy apatite – medical applications - membranes for plasma separation and blood oxygenation-introduction.		
UNIT-V	NANO MATERIALS	9
Nanomaterials: Basics-distinction between nanoparticles and bulk materials- size-dependent properties – synthesis of nanoparticles – chemical methods -metal nanocrystals by reduction, solvothermal synthesis, photochemical synthesis, sonochemical synthesis and chemical vapor deposition - applications in electronics and medicine.		
	Contact Hours :	45

List of Experiments	
1	Construction and determination of EMF of simple electrochemical cells and concentration cells
2	Estimation of acids by pH metry
3	Determination of corrosion rate on mild steel by weight loss method

4	Estimation of mixture of acids by conductometry			
5	Estimation of extent of corrosion of iron pieces by potentiometry			
6	Estimation of copper / ferrous ions by spectrophotometry			
7	Estimation of DO by winkler's method			
8	Determination of total, temporary and permanent hardness by EDTA method			
9	Estimation of alkalinity by indicator method			
10	Estimation of chloride by argentometric method			
11	Determination of molecular weight of a polymer by viscometry method			
12	Determination of phase change temperature of a solid			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**

Course Outcomes: On completion of the course students will be able to	
●	Apply the knowledge of electrochemistry in analyzing basic chemicals by measuring molecular/bulk properties like redox potential, conductance, DO of water and corrosion rate
●	Be conversant about surface modifications involving electrochemical processes
●	Be assertive on types of batteries and fuel cells
●	Apply the knowledge of industrial polymers in various fields
●	Develop nano and biomaterials for medical application

Text Books:	
1	P. C. Jain and Monika Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd,New Delhi, 2015.
2	O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2017.

Reference Books / Web links:	
1	Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, ―Polymer Science, New Age International (P) Ltd., New Delhi, 2011.
2	Sujata V Bhat, "Biomaterials", Narosa Publishing House, New Delhi, 2002.
3	Joon Bu Park, Roderic S, Lakes, "Biomaterials", Springer-Verlag, New York Inc., 2010.
4	PradeepT, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012.

PO/PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CY19142.1	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**2**
CY19142.2	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**1**	**3**	**1**	**3**	**1**	**2**	**2**	**2**
CY19142.3	**2**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**2**	**2**	**1**
CY19142.4	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**1**	**1**	**1**	**1**	**2**	**2**	**3**	**1**
CY19142.5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**2**	**3**	**2**
Average	**2.8**	**2.6**	**2.8**	**2.2**	**1.8**	**2.8**	**2.6**	**1.4**	**2.2**	**1**	**2.2**	**1.8**	**1.8**	**2.4**	**1.6**

Subject Code	Subject Name	Category	L	T	P	C
GE19141	PROGRAMMING USING C	ES	2	0	4	4

Objectives: The student should be made

- To develop simple algorithms for arithmetic and logical problems
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop applications in C using functions, pointers and structures
- To do input/output and file handling in C

UNIT-I GENERAL PROBLEM-SOLVING CONCEPTS **6**

Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

UNIT-II C LANGUAGE - TYPES OF OPERATOR AND EXPRESSIONS **6**

Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants, Declarations - Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.

UNIT-III I/O AND CONTROL FLOW **6**

Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.

UNIT-IV FUNCTIONS AND PROGRAM STRUCTURE **6**

Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Pre-processor, Standard Library Functions and return types.

UNIT-V POINTERS, ARRAYS AND STRUCTURES **6**

Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions, Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typedef, Unions, Bit-fields, File Access -Error Handling, Line I/O, Miscellaneous Functions.

Contact Hours : 30

List of Experiments

1	Algorithm and flowcharts of small problems like GCD.
	Structured code writing with:
2	Small but tricky codes
3	Proper parameter passing
4	Command line Arguments
5	Variable parameter
6	Pointer to functions
7	User defined header
8	Make file utility
9	Multi file program and user defined libraries
10	Interesting substring matching / searching programs
11	Parsing related assignments

Contact Hours : 60

Total Contact Hours : 90

Course Outcomes:

- To formulate simple algorithms for arithmetic and logical problems
- To implement conditional branching, iteration and recursion
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach
- To use arrays, pointers and structures to formulate algorithms and programs
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems

Text Books:

1. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, Pearson Education India; 2nd Edition, 2015.
2. Byron Gottfried, “Programming with C”, Second Edition, Schaum Outline Series, 1996.

Reference Books:

1. Herbert Schildt, “C: The Complete Reference”, Fourth Edition, McGraw Hill, 2017.
2. Yashavant Kanetkar, “Let Us C”, BPB Publications, 15th Edition, 2016.

Web links for virtual lab:	
1	https://www.tutorialspoint.com/compile_c_online.php
2	https://www.codechef.com/ide
3	https://www.jdoodle.com/c-online-compiler
4	https://rextester.com/l/c_online_compiler_gcc

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19141.1	1	2	2	2	1	-	-	-	1	2	1	1	1	1	1
GE19141.2	1	1	1	1	1	-	-	-	-	-	1	1	1	-	-
GE19141.3	1	1	2	1	1	-	-	-	-	-	1	1	1	-	-
GE19141.4	2	2	3	2	1	-	-	-	1	-	2	1	1	-	-
GE19141.5	2	2	3	2	1	-	-	-	-	-	2	1	1	-	-
Average	1.4	1.6	2.2	1.6	1				1	2	1.4	1	1	1	1

Subject Code	Subject Name	Category	L	T	P	C
MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	3	0	0	0

Objectives:

- To create a sense of responsible and active citizenship
- To know about Constitutional and Non- Constitutional bodies
- To understand sacrifices made by the freedom fighters

UNIT-I	**INTRODUCTION**	**9**

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

UNIT-II	**STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**	**9**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT-III	**STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY**	**9**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Panchayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials.

UNIT-IV	**CONSTITUTIONAL FUNCTIONS AND BODIES**	**9**

Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.

UNIT-V	**INDIAN FREEDOM MOVEMENT**	**9**

British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-I**ndian Freedom Struggle under Mahatma Gandhi-**Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.

Total Contact Hours	**:**	**45**

Course Outcomes:

- Understand the functions of the Indian government
- Understand and abide the rules of the Indian constitution
- Gain knowledge on functions of state Government and Local bodies
- Gain Knowledge on constitution functions and role of constitutional bodies and non-constitutional bodies
- Understand the sacrifices made by freedom fighters during freedom movement

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013.
2. BipanChandra, History of Modern India, Orient Black Swan, 2009.
3. BipanChandra, India's Struggle for Independence, Penguin Books, 2016.
4. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014.
5. P K Agarwal and K N Chaturvedi ,PrabhatPrakashan, New Delhi, 1st ed , 2017.

Reference Books / Web links:

1. Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19102.1	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-
MC19102.2	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-
MC19102.3	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-
MC19102.4	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-
MC19102.5	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-
Average	-	-	-	-	-	1	-	2	2	-	-	1	-	-	-

Subject code	Subject Name	Category	L	T	P	C
GE19122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	ES	0	0	2	1

Objectives:	
●	To provide hands on experience on various basic engineering practices in Electrical Engineering.
●	To impart hands on experience on various basic engineering practices in Electronics Engineering.
List of Experiments	
A. ELECTRICAL ENGINEERING PRACTICE	
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 RLC circuit.
5	Measurement of resistance to earth of an electrical equipment.
B. ELECTRONICS ENGINEERING PRACTICE	
1	Study of Electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2	Study of logic gates AND, OR, EXOR and NOT.
3	Generation of Clock Signal.
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5	Measurement of ripple factor of HWR and FWR.
	Total Contact Hours : 30
Course Outcomes: On completion of the course, the students will be able to	
●	Fabricate the electrical circuits
●	formulate the house wiring
●	Fabricate the electronic circuits
●	Design the logic gates and verify the truth table
●	design the AC-DC converter using diodes and passive components
REFERENCES	
1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2	Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4	Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
GE19122.1	3	3	3	2	-	-	2	-	3	-	-	3			
GE19122.2	3	3	2	2	-	-	2	-	3	-	-	3			
GE19122.3	3	3	3	2	-	-	2	-	3	-	-	3			
GE19122.4	3	3	3	2	-	-		-	3	-	-	3			
GE19122.5	3	3	3	2	-	-		-	3	-	-	3			
Average	3	3	2.6	2	-	-	2	-	3	-	-	3			

SEMESTER II

Subject Code	Subject Name	Category	L	T	P	C
MA19252	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES (Common to II sem. B.E.- Computer Science and Engineering, Biomedical Engineering, Electronics and Communication Engineering, Electrical and Electronics Engineering & B.Tech. – Information Technology)	BS	3	1	0	4

Objectives: The student should be made

- To handle practical problems arising in the field of engineering and technology using differential equations
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms

UNIT-I **SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS** **12**

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters –Legendre's linear equations - Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogenous partial differential equations of second and higher order with constant coefficients.

UNIT-II **VECTOR CALCULUS** **12**

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration –Green's theorem, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT-III **ANALYTIC FUNCTIONS** **12**

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 $w = z + c,\ cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT-IV **COMPLEX INTEGRATION** **12**

Cauchy's integral theorem – Cauchy's integral formula **(**excluding proof) – Taylor's and Laurent's series – Singularities – Residues – Residue theorem **(**excluding proof) – Application of residue theorem for evaluation of real integrals - Evaluation of real definite integrals as contour integrals around semi-circle (excluding poles on the real axis).

UNIT-V **LAPLACE TRANSFORM** **12**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions - Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

Total Contact Hours : 60

Course Outcomes:

On completion of the course, students will be able to

- Apply various techniques in solving ordinary differential equations and partial differential equations
- Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals
- Use the concept of Analytic functions, conformal mapping and bilinear transformation
- Use complex integration techniques to solve Engineering problems
- Use Laplace transform and inverse transform techniques in solving differential equations

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Engineering Mathematics –II ,McGraw Hill Education, 2018.

Reference Books:

1. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4. T Veerarajan Transforms and Partial Differential Equations McGraw Hill Education, 2018.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA192521	3	3	3	3	3	2	-	-	-	-	2	2	3	3	2
MA19252.2	3	3	3	3	2	1	-	-	-	-	2	2	3	3	2
MA19252.3	3	3	2	2	2	1	-	-	-	-	1	1	3	2	2
MA19252.4	3	3	2	3	2	1	-	-	-	-	1	1	3	2	2
MA19252.5	3	3	2	2	2	1	-	-	-	-	1	1	3	2	2
Average	3	3	2.4	2.6	2.2	1.2	-	-	-	-	1.4	1.4	3	2.4	2

Subject Code	Subject Name	Category	L	T	P	C
PH19242	PHYSICS FOR ELECTRONICS ENGINEERING Common to II sem. B.E. – Electronics and Communication Engineering & Electrical and Electronics Engineering	BS	3	0	2	4

Objectives: The student should be made

- To understand the essential principles of physics of semiconductor devices and electron transport properties
- To become proficient in magnetic, dielectric and optical properties of materials and nano devices

UNIT-I	ELECTRICAL PROPERTIES OF MATERIALS	9

Classical free electron theory - expression for electrical conductivity - electrons in metals – concept of quantum physics-wave function-Schrodinger equation- particle in a box-one dimension and three dimension - degenerate states - Fermi- Dirac statistics - density of energy states – electron in periodic potential: Bloch theorem– metals and insulators - Brillouin zone - energy bands in solids–- electron effective mass – concept of hole.

UNIT-II	SEMICONDUCTOR PHYSICS	9

Intrinsic semiconductors - energy band diagram - direct and indirect semiconductors - carrier concentration in intrinsic semiconductors -–extrinsic semiconductors - carrier concentration in N-type and P-type semiconductors. Carrier transport: Velocity-electric field relations - drift and diffusion transport – Einstein's relation. Hall effect and applications. P-N junctions - Zener and avalanche breakdown - Ohmic contacts - Schottky diode– MOS capacitor.

UNIT-III	MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS	9

Magnetism in materials - magnetic field and induction - magnetization - magnetic permeability and susceptibility - types of magnetic materials - microscopic classification of magnetic materials. Ferromagnetism: origin and exchange interaction - saturation magnetization and Curie temperature - domain theory. Dielectric materials: Polarization processes - dielectric loss - internal field - Clausius- Mosotti relation- dielectric breakdown - high-k dielectrics.

UNIT-IV	OPTICAL PROPERTIES OF 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 a P- N diode - solar cell - photo detectors - LED - Organic LED -–laser diodes - excitons - quantum confined Stark effect -–quantum dot laser.

UNIT-V	NANOELECTRONIC 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. Zener-Bloch oscillations - resonant tunneling - quantum interference effects - mesoscopic structures: conductance fluctuations and coherent transport. Coulomb blockade effects - single electron phenomena and single electron transistor - magnetic semiconductors -spintronics. Carbon nanotubes: Properties and applications.

Contact Hours	:	45

List of Experiments

1	Determination of Band gap of Semiconducting material.
2	Determination of Hall coefficient of Semiconductor.
3	Experiments on electromagnetic induction – BH-Curve experiment to determine magnetic parameter.
4	Determination of free space permeability using Helmholtz coil.
5	Determination of magnetic susceptibility of water and ferrous liquid using quincke's Method.
6	Measurement of Magneto resistance of Semiconductors.
7	Determination of Solar Cell parameters.
8	To determine the work function and threshold frequency using Einstein's Photoelectric effect.

9	Diffraction- Determination of wavelength of diode laser.			
10	Measurement of speed of light using fiber cable.			
11	Determination of quantum efficiency of photo diode from I-V Characteristic curve.			
12	Determination of Resonance frequency of LC circuit and LCR circuits.			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**
Course Outcomes: On completion of the course, students will be able to				
●	Apply the concept of electron transport in devices			
●	Analyze the physical properties of semiconductors			
●	Analyze the properties of magnetic and dielectric materials			
●	Analyze the properties of optical materials used for optoelectronics			
●	Analyze the quantum behaiour in nanoelectronic devices			
Text Books:				
1	Kasap, S.O. Principles of Electronic Materials and Devices, McGraw-Hill Education, 2007.			
2	Wahab, M.A. Solid State Physics: Structure and Properties of Materials. Narosa Publishing House, 2009.			
Reference Books / Web links:				
1	Garcia, N. & Damask, A. Physics for Computer Science Students. Springer-Verlag, 2012.			
2	Hanson, G.W. Fundamentals of Nanoelectronics. Pearson Education, 2009.			
3	Rogers, B., Adams, J. & Pennathur, S. Nanotechnology: Understanding Small Systems. CRC Press, 2014**.**			
4	S. O. Pillai, Solid state physics, New Age International, 2015.			
5	Umesh K Mishra &Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2008.			

PO/PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
PH19242.1	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**1**
PH19242.2	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
PH19242.3	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
PH192424	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
PH19242.5	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
Average	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**0.8**	**1**	**1**	**1.6**	**1.6**	**1**

Subject Code	Subject Name	Category	L	T	P	C
GE19101	ENGINEERING GRAPHICS	ES	2	2	0	4

Objectives: The student should be made

- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings
- To improve their visualization skills so that they can apply this skill in developing new products
- To improve their technical communication skill in the form of communicative 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 and dimensioning. Basic Geometrical constructions.

UNIT-I	PLANECURVES AND FREE HAND SKETCH	11

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, 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.

UNIT-II	PROJECTION OFPOINTS, LINESAND PLANESURFACE	12

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT-III	PROJECTION OF SOLIDS	12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

UNIT-IV	PROJECTION OF SECTIONED SOLIDS ANDDEVELOPMENTOF SURFACES	12

Sectioning of 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 the section.

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT-V	ISOMETRIC AND PERSPECTIVE PROJECTIONS	12

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Total Contact Hours	:	60

Course Outcomes: After learning the course, the students should be able

- To construct different plane curves and free hand sketching of multiple views from pictorial objects
- To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
- To draw the projection of solids in different views
- To draw the projection of Sectioned solids and development of surfaces of solids
- To visualize and prepare Isometric and Perspective view of simple solids

Text Book (s):

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2017.

Reference Books(s) / Web links:

1. Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd. 2013.
2. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P) Limited, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19101.1	1	1	-	1	2	1	-	-	2	3	1	2	1	-	2
GE19101.2	1	1	-	1	2	1	-	-	2	3	1	2	1	-	2
GE19101.3	1	1	-	1	2	1	-	-	2	3	1	2	-	-	2
GE19101.4	1	1	-	1	2	1	-	-	2	3	1	2	-	-	2
GE19101.5	1	1	-	1	2	1	-	-	2	3	1	2	-	-	2
Average	1	1	-	1	2	1	-	-	2	3	1	2	1	-	2

Subject Code	Subject Name	Category	L	T	P	C
CS19241	DATA STRUCTURES	ES	3	0	4	5

Objectives: The student should be made

- To apply the concepts of List ADT in the applications of various linear and nonlinear data structures
- To demonstrate the understanding of stacks, queues and their applications
- To analyze the concepts of tree data structure
- To understand the implementation of graphs and their applications
- To be able to incorporate various searching and sorting techniques in real time scenarios

UNIT-I	LINEAR DATA STRUCTURES – LIST	9

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

UNIT-II	LINEAR DATA STRUCTURES – STACKS, QUEUES	9

Stack ADT – Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix to postfix expression - Queue ADT – Operations - Circular Queue –DEQUE –applications of queues.

UNIT-III	NON-LINEAR DATA STRUCTURES – TREES	9

Tree Terminologies- Binary Tree–Representation-Tree traversals – Expression trees – Binary Search Tree–AVL Trees –Splay Trees - Binary Heap – Applications.

UNIT-IV	NON LINEAR DATA STRUCTURES - GRAPHS	9

Graph Terminologies – Representation of Graph – Types of graphs - Breadth-first traversal - Depth-first traversal –Topological Sort - Shortest path - Dijikstra's Algorithm - Minimum Spanning Tree- Prim's Algorithm.

UNIT-V	SEARCHING, SORTING AND HASHING TECHNIQUES	9

Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort – Shell sort – Quick sort - Merge Sort. Hashing- Hash Functions –Collision resolution strategies- Separate Chaining – Open Addressing – Rehashing.

Contact Hours	**:**	**45**

DATA STRUCTURES LABORATORY

List Of Experiments

1.	Array implementation of Stack and Queue ADTs
2.	Array implementation of List ADT
3.	Linked list implementation of List, Stack and Queue ADTs
4.	Applications of List, Stack and Queue ADTs
5.	Implementation of Binary Trees and operations of Binary Trees
6.	Implementation of Binary Search Trees
7.	Implementation of AVL Trees
8.	Implementation of Heaps using Priority Queues
9.	Graph representation and Traversal algorithms
10.	Applications of Graphs
11.	Implementation of searching and sorting algorithms
12.	Hashing –any two collision techniques

Contact Hours	**:**	**60**
Total Contact Hours	**:**	**105**

Course Outcomes:

- Analyze the various data structure concepts
- Implement Stacks and Queue concepts for solving real-world problems
- Analyze and structure the linear data structure using tree concepts
- Critically analyse various non-linear data structures algorithms
- Apply different Sorting, Searching and Hashing algorithms

Text Book (s):

1. Mark Allen Weiss, -"Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2002.
2. ReemaThareja, -"Data Structures Using C", Second Edition, Oxford University Press, 2014.

Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, - "Introduction to Algorithms", Second Edition, McGraw Hill, 2002.
2. Aho, Hopcroft and Ullman, - "Data Structures and Algorithms", Pearson Education, 1983.

3	Stephen G. Kochan, -"Programming in C", 3rd edition, Pearson Education.
4	Ellis Horowitz, SartajSahni, Susan Anderson-Freed, - "Fundamentals of Data Structures in C", Second Edition, University Press, 2008.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS19241.1	**1**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**
CS19241.2	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CS19241.3	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CS19241.4	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**
CS19241.5	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**
Average	**1**	**1.2**	**1.8**	**1.2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.6**	**-**	**-**	**1**

Subject Code	Subject Name	Category	L	T	P	C
EC19241	ELECTRON DEVICES	PC	3	0	2	4

Objectives: The student should be made		
●	To acquire knowledge about PN Junction diode	
●	To study in detail about the operation and characteristic features of BJT	
●	To introduce the operation and characteristic features of JFET and MOSFET	
●	To study biasing techniques of BJT, JFET and MOSFET	
●	To understand the operation and characteristic features of special semiconductor devices	
UNIT-I	**SEMICONDUCTOR DIODE**	**9**
Introduction to Semiconductor Physics, 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, Applications of PN junction diode.		
UNIT-II	**BJT**	**9**
NPN and PNP configurations and their characteristics, Early effect, current equations, input and output characteristics of CE, CB and CC, h-parameter model, Hybrid -π model, Eber's Moll model		
UNIT-III	**JFET AND MOSFET**	**9**
JFET, N-channel and P-channel, drain and transfer characteristics, MOSFET, D-MOSFET, E-MOSFET, Drain and Transfer characteristics.		
UNIT-IV	**BIASING OF BJT AND FET AMPLIFIERS**	**9**
DC Load line, operating point, various biasing methods for BJT, Stability-Bias compensation, Thermal stability, Biasing of JFET and MOSFET.		
UNIT-V	**SPECIAL SEMICONDUCTOR DEVICES**	**9**
Schottky barrier diode, Zener diode, Varactor diode, Tunnel diode, UJT, SCR, DIAC, TRIAC, LED, LCD,LASER diode, LDR, photodiode and solar cell.		
	Contact Hours : 45	

	List of Experiments	
1	Characteristics of PN junction diode.	
2	Characteristics of Zener diode.	
3	Characteristics of BJT.	
4	Clippers and Clampers.	
5	Characteristics of JFET.	
6	Characteristics of UJT.	
7	SCR Characteristics.	
	Contact Hours : 30	
	Total Contact Hours : 75	

Course Outcomes:	
●	Demonstrate the PN junction diode functions and its characteristics
●	Develop a high degree of familiarity the BJT terminal characteristics
●	Identify the characteristics of FET and MOSFETs
●	Analyze various types of biasing of BJT
●	Identify a suitable semiconductor device for any given application

Text Book (s):	
1	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory," 11th edition, Prentice Hall, 2012.
2	D. Neamen , D. Biswas "Semiconductor Physics and Devices," 4/e, Mc Graw-Hill Education, 2012.

Reference Books(s) / Web links:	
1	G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
2	S. M. Sze and K. N. Kwok, "Physics of Semiconductor Devices," 3rd edition, John Wiley& Sons, 2006.
3	C.T. Sah, "Fundamentals of solid state electronics," World Scientific Publishing Co. Inc, 1991.
4	Y. Tsividis and M. Colin, "Operation and Modeling of the MOS Transistor," Oxford Univ.Press, 2011
5	All-in-One Electronic Simplified, A.K. Maini, Khanna Publishing House.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19241.1	**3**	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
EC19241.2	**3**	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
EC19241.3	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**2**
EC19241.4	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
EC19241.5	**3**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**
Average	**3**	**2.6**	**2.4**	**2.6**	**1.4**	**1.4**	**1**	**2**	**1.4**	**1**	**2**	**2**	**2.2**	**2.2**	**2**

Subject Code	Subject Name	Category	L	T	P	C
MC19101	ENVIROMENTAL SCIENCE AND ENGINEERING (Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering & Mechatronics and B.Tech. – Biotechnology, Chemical Engineering &Food Technology and Common to II sem. B.E. – Computer Science and Engineering, Electronics and Communication Engineering & Electrical and Electronics Engineering and B.Tech. – Information Technology)	MC	3	0	0	0

Objectives: The student should be made

- To understand the importance of natural resources, pollution control and waste management
- To provide the students about the current social issues and environmental legislations

UNIT-I NATURAL RESOURCES **9**

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non-renewable energy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II ENVIRONMENTAL POLLUTION **9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.

Soil pollution: definition-causes-effects and control of soil pollution.

UNIT-III SOLID WASTE MANAGEMENT **9**

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes

Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling, neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

UNIT-IV SOCIAL ISSUES AND THE ENVIRONMENT **9**

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT-V TOOLS FOR ENVIRONMENTAL MANAGEMENT **9**

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts-environmental protection act1986- role of non-government organizations- international conventions and protocols.

Contact Hours : 45

Course Outcomes:

On completion of the course students will be able to

- Be conversant to utilize resources in a sustainable manner
- Find ways to protect the environment and play proactive roles
- Apply the strategies to handle different wastes
- Develop and improve the standard of better living.
- Be conversant with tools of EIA and environmental legislation

Text Books:

1. Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

Reference Books / Web links:

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi,2007.
2. ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015.
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, Cengage Learning India PVT, LTD, Delhi, 2014.
4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rdedition, Oxford University Press,2015.

5	De. A.K., "Environmental Chemistry", New Age International, New Delhi, 1996.
6	K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19101.1	**3**	**2**	**3**	**2**	**1**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**1**
MC19101.2	**3**	**2**	**3**	**2**	**1**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**
MC19101.3	**3**	**2**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**
MC19101.4	**3**	**2**	**3**	**1**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**2**
MC19101.5	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**1**
Average	**3**	**2**	**2.8**	**1.4**	**1.2**	**2.6**	**3**	**1.8**	**1.2**	**1.4**	**1.2**	**1.6**	**0.8**	**1.4**	**1.6**

Subject Code	Subject Name	Category	L	T	P	C
GE19121	ENGINEERING PRACTICES -CIVIL AND MECHANICAL	ES	0	0	2	1

Objectives:

- To provide hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments

I	**CIVIL ENGINEERING PRACTICE**	**15**
	Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.	
	Plumbing Works:	
1	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.	
2	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.	
3	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.	
	Carpentry Works:	
4	Study of joints in roofs, doors, windows and furniture.	
5	Hands-on-exercise: Woodwork, joints by sawing, planning and chiseling.	
II	**MECHANICAL ENGINEERING PRACTICE**	**15**
Welding:		
1	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.	
2	Gas welding practice.	
3	**Basic Machining:** Simple Turning and Taper turning.	
	Drilling Practice.	
4	**Sheet Metal Work:** Forming & Bending:	
	Model making – Trays and funnels.	
	Different type of joints.	
5	**Machine assembly practice:** Study of centrifugal pump	
	Study of air conditioner	
	Total Contact Hours : 30	

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19121.1	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1
GE19121.2	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1
GE19121.3	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1
GE19121.4	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1
GE19121.5	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1
Average	2	1	1	-	2	2	2	-	1	-	2	2	-	-	1

SEMESTER III

Subject Code	Subject Name	Category	L	T	P	C
MA19352	**TRANSFORMS AND SPECIAL FUNCTIONS (Common to III sem. B.E. Electronics and Communication Engineering & Biomedical Engineering)**	BS	3	1	0	4

Objectives:

- To introduce Fourier series and to solve boundary value problems that arise in the field of Engineering.
- To acquaint the student with different transform techniques and special functions for use in handling Engineering problems.

UNIT-I	**FOURIER SERIES**	**12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT-II	**BOUNDARY VALUE PROBLEMS**	**12**

Classification of PDE – Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (excluding insulated edges).

UNIT-III	**FOURIER TRANSFORMS**	**12**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.

UNIT-IV	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.

UNIT-V	**BESSEL FUNCTION**	**12**

Bessel Equation – Bessel functions of first kind – properties of $J_n(x)$ - Recurrence relations – Bessel Integral for $J_n(x)$ – orthogonality.

Total Contact Hours	**:**	**60**

Course Outcomes: On completion of course, students will be able to

- To construct Fourier series for different periodic functions and to evaluate infinite series.
- Classify different types of PDE and solve boundary value problems.
- Solve Engineering problems using Fourier transform techniques.
- Solve difference equations using Z – transforms that arise in discrete time systems.
- Use Bessels function to solve problems in Communication Engineering.

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", 44rd Edition, Khanna Publishers, Delhi, 2016.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd., New Delhi, Second reprint, 2016.
3. P. Sivaramakrishna Das, C. Vijayakumari, "Mathematics – I", Pearson India Education. First edition 2019.

Reference Books / Web links:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing, New Delhi, 2017.
3. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.
4. Peter V. O' Neil, "Advanced Engineering Mathematics", 7th Edition, Global Engineering, 2012.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19352.1	3	3	2	3	-	-	-	-	-	-	-	2	-	1	1
MA19352.2	3	3	2	3	-	-	-	-	-	-	-	2	2	1	1
MA19352.3	3	3	3	3	1	-	-	-	-	-	-	2	-	1	1
MA19352.4	3	3	2	3	-	-	-	-	-	-	-	2	2	1	1
MA19352.5	3	2	2	2	1	-	-	-	-	-	-	2	1	1	1
Average	3	2.8	2.1	2.8	1	-	-	-	-	-	-	2	1.3	1	1

Subject Code	Subject Name	Category	L	T	P	C
EE19241	BASIC ELECTRICAL ENGINEERING (Common to Automobile, ECE, Mechanical & Mechatronics)	ES	3	0	2	4

Objectives:

To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.

To impart knowledge on series resonance, parallel resonance and three phase balanced circuits.

To provide knowledge on the principles of electrical machines.

To learn the concepts of different types of power converter and batteries.

To teach methods of experimentally analysing electrical circuits and machines

UNIT-I	**DC CIRCUITS**	**9**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

UNIT-II	**AC CIRCUITS**	**9**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections

UNIT III	**DC MOTORS AND TRANSFORMERS**	**9**

Construction, working, torque-speed characteristic and speed control of DC motors Construction and principle of operation- EMF Equation- regulation, losses and efficiency of Single Phase Transformers - Auto-transformer.

UNIT-IV	**AC ROTATING MACHINES**	**9**

Construction and working of Synchronous Generators-EMF Equation - Construction and working- torque-slip characteristic- starting methods of three phase induction motors-Single-phase induction motors- Construction and Working of Permanent Magnet Brushless DC Motors and Stepper Motors.

UNIT-V	**BATTERIES AND POWER CONVERTERS**	**9**

Types of Batteries, Important Characteristics for Batteries -DC-DC buck and boost converters- duty ratio control - Single-phase and three-phase voltage source inverters – Sinusoidal modulation

Total Contact Hours	**:**	**45**

List of Experiments

1	Experimental verification of Kirchhoff's voltage and current laws.
2	Experimental verification of network theorems (Thevenin and, Norton Theorems).
3	Load test on DC shunt motor.
4	Speed control of DC shunt motor.
5	Load test on single-phase transformer.
6	Open circuit and short circuit tests on single phase transformer.
7	Speed control of chopper fed DC motor.

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

Course Outcomes:

On completion of the course, the students will be able to

- analyse DC and AC circuits and apply circuit theorems.
- realize series resonance, parallel resonance and three phase balanced circuits.
- understand the principles of electrical machines.
- understand the principles of different types of power converter and batteries.
- experimentally analyze the electric circuits and machines.

Text Book (s):

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, PHI Third Edition, New Delhi, 2014.
3. David Linden and Thomas B. Reddy, " Handbook of Batteries" McGraw-Hill Professional,2001

Reference Books(s) / Web links:

1. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
2. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

4	L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5	P.S.Bimbra “Power Electronics”, Khanna Publishers, 4th Edition, 2007.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE 19241.1	**3**	**3**	**2**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**
EE 19241.2	**3**	**3**	**2**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**
EE 19241.3	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**2**	**3**	**3**	**3**
EE 19241.4	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**3**
EE 19241.5	**3**	**3**	**2**	**3**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**3**
Average	**3**	**3**	**2**	**3**	**3**	**1.4**	**1.6**	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EC19301	ANALOG CIRCUITS- I	PC	3	0	0	3

Objectives: The student should be made

- To analyse the BJT amplifiers using small signal model
- To analyse the FET amplifiers using small signal model
- To determine the frequency response of BJT and FET amplifiers
- To analyse Feedback Amplifiers and Oscillators
- To understand the concepts of Power Amplifiers and IC MOSFET

UNIT-I BJT SMALL SIGNAL AMPLIFIERS **9**

Small signal analysis of common emitter amplifier, Common Collector and Common Base amplifiers, Differential amplifiers, CMRR, Cascaded stages, Cascode amplifier.

UNIT-II JFET AND MOSFET AMPLIFIERS **9**

Small signal analysis of JFET and MOSFET- Common source amplifier, voltage swing limitations, Source follower and Common Gate amplifiers, BiMOS Cascode amplifier.

UNIT-III FREQUENCY ANALYSIS OF BJT AND MOSFET AMPLIFIERS **9**

Miller effect, Low frequency analysis of BJT and MOSFET, High frequency analysis of CE and MOSFET CS amplifier, short circuit current gain of CC amplifier, cut-off frequencies of CE and CB amplifiers (f_α and f_β), Gain bandwidth product, Determination of bandwidth for multistage amplifiers.

UNIT-IV FEEDBACK AMPLIFIERS AND OSCILLATORS **9**

Feedback topologies-Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth, noise and non-linear distortion. Oscillators-Introduction, Barkhausen Criterion, Analysis of RC oscillators, LC oscillators.

UNIT-V POWER AMPLIFIERS AND IC MOSFET **9**

Power amplifiers-Class A, Class B, Class C and Class D. IC biasing- current steering circuit using MOSFET, Amplifier with active loads – Enhancement and depletion load, CMOS- common source amplifier, source follower and differential amplifier- CMRR.

Total Contact Hours : 45

Course Outcomes: On completion of the course, students will be able to

- Identify DC and AC characteristics of BJT amplifier circuits
- Explain DC and AC characteristics of FET amplifier circuits
- Determine the frequency response of BJT and MOSFET amplifiers
- Analyse Feedback Amplifiers and Oscillators
- Design the Power Amplifiers and IC MOSFET

Text Books:

1. Donald. A. Neamen, Electronic Circuit Analysis and Design – 2nd Edition, Tata McGraw Hill, 2009.
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, “Micro Electronic Circuits”, 6th Edition, Oxford University Press, 2010.

Reference Books / Web links:

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw Hill, 2007.
2. Millman.J. and Halkias C.C, “Integrated Electronics”, McGraw Hill, 2001.
3. D.Schilling and C.Belove, “Electronic Circuits”, 3rd Edition, McGraw Hill, 1989.
4. David A., “Bell Electronic Devices and Circuits”, Oxford Higher Education Press, 5th Edition, 2010.

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19301.1	3	3	3	1	3	-	-	-	1	-	2	1	1	1	3
EC19301.2	3	3	3	2	3	-	-	-	1	-	2	1	1	1	3
EC19301.3	3	2	1	3	3	-	-	-	1	-	2	1	1	1	3
EC19301.4	3	3	3	3	-	1	1	-	1	-	2	3	2	3	3
EC19301.5	3	2	1	3	-	1	1	-	1	-	-	3	2	3	3
Average	3	2.6	2.2	2.4	1.8	0.4	0.4	-	1	-	1.6	1.8	1.4	1.8	3

Subject Code	Subject Name	Category	L	T	P	C
EC19302	DIGITAL ELECTRONICS	PC	3	0	0	3

Objectives: The student should be made

- To learn the basic postulates of Boolean algebra and infer the methods for simplifying Boolean expressions
- To understand the design of various Combinational circuits.
- To extrapolate the design of Synchronous Sequential circuits using Flip-Flops.
- To know the design procedure of Asynchronous Sequential circuits and its problems.
- To understand the concept of Programmable Logic Devices for the design of digital circuits and Familiar with Verilog HDL.

UNIT-I	MINIMIZATION TECHNIQUES AND LOGIC GATES	9

Review of Number systems and Complements. **Fundamentals:** Boolean postulates and laws, De-Morgan's Theorem, Principle of Duality, Boolean expression, Minterm, Maxterm, Sum of Products (SOP), Product of Sums (POS). Minimization Techniques: Minimization of Boolean expressions using Boolean laws, Karnaugh map, Quine McCluskey method of minimization, don't care conditions. **Logic Gates:** Implementation of Logic Functions using gates, NAND–NOR implementations, Tristate gates.

UNIT-II	COMBINATIONAL CIRCUITS	9

Half adder, Full Adder, Half subtractor, Full subtractor, Code converters, Parity generator, Parity checker, Magnitude Comparator, BCD adder, Binary Multiplier, Multiplexer-Logic function implementation, Demultiplexer, Encoder, Decoder, Parallel Binary Adder-Fast Adder/Carry Look Ahead adder, Parallel Binary Subtractor, Parallel Binary Adder/Subtractor.

UNIT-III	SYNCHRONOUS SEQUENTIAL CIRCUITS	9

Memory elements: Latches, Flip-flops: RS, JK, D, T, Master-Slave, Triggering of Flip Flops, Realization of one flip flop using other flip flop. **Design:** Synchronous and Asynchronous counters - Up/Down counter, Modulo–N counter. Shift Registers - SISO, SIPO, PISO, PIPO, Universal Shift Register, Shift Register Counters - Ring counter, Shift counter.

UNIT-IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	9

Fundamental Mode and Pulse Mode Circuit Design, Incompletely Specified State Machines, Problems in Asynchronous Circuits- Races, Cycles and Hazards, Race free state assignment.

UNIT-V	PROGRAMMABLE LOGIC DEVICES & HDL	9

Programmable Logic Devices (PLD): Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA), Complex Programmable Logic Devices (CPLD), Implementation of Combinational Logic Circuits using PROM, PLA, PAL. **Logic Families:** TTL and CMOS Logic and their characteristics.
Verilog HDL: Introduction to basic programs for combinational and sequential circuits.

	Total Contact Hours	:	45

Course Outcomes: On completion of course, students will be able to

- Simplify the Boolean expressions using basic postulates of Boolean algebra with suitable minimization techniques.
- Design and Implement Combinational circuits.
- Construct Synchronous Sequential circuits using Flip-Flops.
- Design Asynchronous Sequential circuits and analyse its problems.
- Implement digital circuits using Programmable Logic Devices and Familiar with Verilog HDL.

Text Books:

1. Morris Mano & Michael D Ciletti, "Digital Design: With an Introduction to Verilog HDL, 5th Edition, Pearson Education, 2013.
2. Charles H.Roth. "Fundamentals of Logic Design", 7th Edition, Thomson Learning, 2014.

Reference Books / Web links:

1. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.
2. John F.Wakerly, "Digital Design", Fourth Edition, Pearson/PHI, 2008
3. John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.
4. Donald P.Leach and Albert Paul Malvino, "Digital Principles and Applications", 6th Edition, TMH, 2006.
5. Donald D.Givone, "Digital Principles and Design", TMH, 2003.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19302.1	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**3**	**1**	**1**
EC19302.2	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**3**	**3**	**2**
EC19302.3	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**
EC19302.4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**
EC19302.5	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**2**
Average	**3**	**2.8**	**2.8**	**2.6**	**2**	**2.4**	**1.8**	**1.6**	**1.8**	**1.2**	**2**	**1.8**	**3**	**2.6**	**1.8**

Subject Code	Subject Name	Category	L	T	P	C
EC19303	SIGNALS AND SYSTEMS	PC	3	0	0	3

Objectives: The student should be made

- To understand the basic properties of Signals & Systems and the various methods of classification
- To learn Fourier transform, Laplace Transform & Z- transform with their properties
- To learn the characteristics of CT and DT LTI systems using Laplace Transform & Z- transform

UNIT-I CLASSIFICATION OF SIGNALS AND SYSTEMS **10**

Continuous time signals (CT signals) & Discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, complex Exponential and Sinusoidal signals. Classification of CT and DT signals- Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals. CT systems and DT systems - Classification of systems: Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

UNIT-II ANALYSIS OF CONTINUOUS TIME SIGNALS **10**

Fourier series analysis-spectrum of Continuous Time signals, Fourier & Laplace Transforms and its Properties in CT signal analysis.

UNIT-III ANALYSIS OF DISCRETE TIME SIGNALS **9**

Sampling theorem, DTFT, Properties of DTFT, Z Transform- ROC and its Properties, Inverse Z- Transform- long division method, partial fraction expansion, Cauchy's residue Theorem, Signal analysis using Z-Transform properties.

UNIT-IV LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS **8**

Differential Equations-Block diagram representation, Impulse response, Convolution integrals, Fourier and Laplace transforms in analysis of CT systems.

UNIT-V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS **8**

Difference Equations, Block diagram representation, Impulse response, Convolution sum, Discrete Time Fourier and Z Transform analysis of DT systems, Introduction to STFT.

Total Contact Hours : 45

Outcomes: Students will be able to:

- Distinguish the basic properties of Signals & Systems
- Extrapolate the properties of Laplace transform and Fourier transform in signal analysis
- Apply Z -transform and DTFT in signal analysis
- Characterize continuous time LTI systems using Fourier and Laplace Transforms
- Analyze discrete time LTI systems using Z transform and DTFT

Text Books:

1	Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, 2007.
2	B. P. Lathi, "Principles of Linear Systems and Signals", new edition, Oxford, 2017.

Reference Books / Web links:

1	R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.
2	John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.
3	M.J.Roberts, "Signals & Systems Analysis using Transform Methods & MATLAB", Tata McGraw Hill, 2007.
4	P. Ramakrishna Rao & Shankar Prakriya, Signals and Systems, 2e,Tata McGraw Hill,2013

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19303.1	3	3	2	1	-	1	-	1	1	1	1	2	3	1	1
EC19303.2	3	3	2	1	2	1	-	1	1	1	1	2	3	3	2
EC19303.3	3	3	2	1	2	1	-	1	1	1	1	2	2	3	2
EC19303.4	3	3	2	3	2	1	-	1	1	1	1	2	3	3	2
EC19303.5	3	3	2	3	2	1	-	1	1	1	1	2	2	3	2
Average	3	3	2	1.6	2	1	_	1	1	1	1	2	2.6	2.6	1.8

Subject Code	Subject Name	Category	L	T	P	C
MC19301	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	MC	3	0	0	0

Objectives:

- This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I **Introduction to Indian Knowledge System** **9**

Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda-Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra.

UNIT-II **Modern Science and Yoga** **9**

Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.

UNIT-III **Indian Philosophical Tradition** **9**

Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Vedanta- Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies.

UNIT-IV **Indian Linguistic Tradition** **9**

Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.

UNIT-V **Indian Artistic Tradition** **9**

Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.

Total Contact Hours : 45

Course Outcomes: On completion of the course students will be able to

- Understand basic structure of the Indian Knowledge System
- Apply the basic knowledge of modern science and Indian knowledge system in practise
- Understand the importance Indian Philosophical tradition
- Appreciate the Indian Linguistic Tradition.
- Understand the concepts of traditional Indian art forms

Text Books:

1. V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan.
3. Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan.
4. Fritzof Capra, Tao of Physics.
5. Fritzof Capra, The Wave of life.

Reference Books:

1. VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Arnakulam.
2. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3. GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,VidyanidhiPrakashan, Delhi 2016.
4. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, VidyanidhiPrakashan, Delhi 2016.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19301.1	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.2	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.3	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.4	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.5	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
Average	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
EC 19311	ANALOG AND DIGITAL CIRCUITS LABORATORY	PC	0	0	4	2

Objectives: The student should be made	
●	To Understand the characteristics, design and analyse the frequency response of CE, CB, CC and CS amplifiers.
●	To Analyse the CMRR value of differential amplifier and frequency response of Feedback amplifiers.
●	To Design and Implement combinational circuits like Converter, Mux/ Demux.
●	To Design and Implement sequential circuits like Counters, Shift Registers.
●	To Simulate Analog circuits using PSPICE and Digital circuits using Verilog HDL.
List of Analog Experiments	
1	Frequency Response of CE, CB, CC amplifiers.
2	Frequency Response of CS amplifier.
3	Differential amplifier- CMRR measurement.
4	Frequency Response of Feedback amplifiers.
5	Realization of Common Emitter and Common Source amplifiers using PSPICE.
List of Digital Experiments	
6	Design and Implementation of Binary to Gray and Gray to Binary code converters using logic gates.
7	Design and Implementation of Multiplexer and De-multiplexer using logic gates.
8	Design and Implementation of BCD Synchronous and Decade, Mod-14 Asynchronous counters.
9	Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- Flop.
10	Realization of digital circuits using Verilog HDL Combination Circuits: Half adder, Full adder, Half subtractor, Full subtractor, Multiplexer, Demultiplexer Sequential circuits: Flip Flops, Shift Registers, Counters.
	Total Contact Hours : 60
Course Outcomes: On completion of the course, the students will be able to	
●	Design and analyse CE, CB, CC and CS amplifiers.
●	Measure CMRR of Differential amplifier and frequency response of Feedback amplifiers.
●	Design and Implement combinational circuits.
●	Design and Implement sequential circuits.
●	Simulate Analog and Digital circuits.
References	
1	Donald .A. Neamen, Electronic Circuit Analysis and Design – 2nd Edition, Tata McGraw Hill, 2009.
2	Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3	M. Morris Mano, “Digital Design”, 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
4	Charles H.Roth. “Fundamentals of Logic Design”, 7th Edition, Thomson Learning, 2014.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC 19311.1	3	3	3	3	2	2	2	2	3	3	2	2	2	2	2
EC 19311.2	3	3	3	3	2	2	2	2	3	3	2	2	2	2	2
EC 19311.3	3	3	3	3	2	2	2	2	3	3	2	2	2	2	2
EC 19311.4	3	3	3	3	2	2	2	2	3	3	2	2	2	2	2
EC 19311.5	3	3	3	2	3	2	2	2	3	3	2	3	2	2	2
Average	3	3	3	2.8	2.2	2	2	2	3	3	2	2.2	2	2	2

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19211	PROBLEM SOLVING AND PROGRAMMING IN PYTHON (With effect from 2021 batch onwards) Common to all branches of B.E / B.Tech programmes (except – CSE, CSBS, CSD, IT, AI/ML)	ES	1	0	4	3

Course Objectives:

●	To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
●	To write, test, and debug simple Python programs with conditionals, and loops and functions
●	To develop Python programs with defining functions and calling them
●	To understand and write python programs with compound data- lists, tuples, dictionaries
●	To search, sort, read and write data from/to files in Python.

List of Experiments

1.	Study of algorithms, flowcharts and pseudocodes.
2.	Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.
3.	Experiments based on Variables, Datatypes and Operators in Python.
4.	Coding Standards and Formatting Output.
5.	Algorithmic Approach: Selection control structures.
6.	Algorithmic Approach: Iteration control structures.
7.	Experiments based on Strings and its operations.
8.	Experiments based on Lists and its operations.
9.	Experiments based on Tuples and its operations.
10.	Experiments based on Sets and its operations.
11.	Experiments based on Dictionary and its operations.
12.	Functions: Built-in functions.
13.	Functions: User-defined functions.
14.	Functions: Recursive functions.
15.	Searching techniques: Linear and Binary.
16.	Sorting techniques: Bubble and Merge Sort.
17.	Experiments based on files and its operations.
	Contact Hours : 75

Course Outcomes:

On completion of the course, students will be able to:

●	Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
●	Write, test, and debug simple Python programs with conditionals and loops.
●	Develop Python programs step-wise by defining functions and calling them.
●	Use Python lists, tuples, dictionaries for representing compound data.
●	Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:

1.	Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

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 inPython: 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 ProblemSolving Focus, Wiley India Edition, 2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19211.1	**2**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**	**3**	**3**	**-**
GE19211.2	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**3**	**2**	**-**
GE19211.3	**1**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**	**3**	**2**
GE19211.4	**2**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**2**	**2**
GE19211.5	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**2**	**2**
Average	**1.8**	**1.6**	**2.2**	**1.6**	**1.8**	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**1.4**	**1**	**2.4**	**2.4**	**2**

SEMESTER IV

Subject Code	Subject Name	Category	L	T	P	C
MA19452	PROBABILITY AND RANDOM PROCESSES (Common to IV sem. B.E. Electronics and Communication Engineering & Biomedical Engineering)	BS	3	1	0	4

Objectives:

- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems etc in communication engineering.

UNIT-I	**ONE – DIMENSIONAL RANDOM VARIABLE**	**12**

Discrete and continuous random variables – Moments – Moment generating function –Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions.

UNIT-II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**12**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables-Applications of Central Limit Theorem.

UNIT-III	**RANDOM PROCESSES**	**12**

Classification – Stationary process – Markov process - Poisson process and its properties – Discrete parameter Markov chain – Chapman Kolmogorov Theorem (without proof) – Limiting distributions.

UNIT-IV	**CORRELATION AND SPECTRAL DENSITIES**	**12**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT-V	**LINEAR SYSTEMS WITH RANDOM INPUTS**	**12**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and Cross correlation functions of input and output.

Total Contact Hours	**:**	**60**

Course Outcomes: On completion of course, students will be able to

- Apply the basic concepts of probability, one dimensional and two dimensional Random Variables.
- Apply the concept of correlation and regression in real life situation.
- Analyse signals which evolve with respect to time in a probabilistic manner.
- Develop skills in solving problems on power spectral density function.
- Develop skills in solving problems in linear time invariant systems.

Text Books:

1. Ibe.O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier, 2nd IndianReprint, 2014.
2. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc GrawHill, 4th Edition, New Delhi, 2017.
3. Veerarajan T., ‘Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks’, 3rd Edition, McGraw Hill, 2017.

Reference Books / Web links:

1. Yates R.D. and Goodman. D.J., "Probability and Stochastic Processes", 2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
2. Stark H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition,Pearson Education, Asia, 2002.
3. Miller S. L. and Childers. D. G., "Probability and Random Processes with Applications to Signal Processing and Communications", 2nd Edition Academic Press, 2012.
4. Hwei Hsu, "Schaum‟s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata Mc Graw Hill Edition, 3rd Edition ,New Delhi, 2014.
5. Cooper G.R., Mc Gillem. C.D., "Probabilistic Methods of Signal and System Analysis", 3rd Indian Edition, Oxford University Press, New Delhi, 2012.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19452.1	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**1**
MA19452.2	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**
MA19452.3	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
MA194524	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**
MA19452.5	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
Average	**3**	**3**	**2.4**	**2.6**	**1.4**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2.2**	**1.6**	**1.6**

Subject Code	Subject Name	Category	L	T	P	C
EC19401	MICROPROCESSORS AND MICROCONTROLLERS	PC	3	0	0	3

Objectives:

- To study the architecture, functions and programming of 8085 microprocessor.
- To learn the concepts of 8086 architecture and multi-processor configuration.
- To understand the methods of interfacing peripheral devices to a microprocessor.
- To analyze the architecture of 8051 microcontroller and its case study.
- To interpret PIC and Arduino usage and its applications.

UNIT-I	**THE 8085 MICROPROCESSORS**	**9**

8085 Architecture –Addressing modes–Instruction sets– Interrupts – Basic Timing diagram– Assembly Language Programming.

UNIT-II	**THE 8086 MICROPROCESSORS**	**9**

8086 architecture – 8086 signals – Addressing modes –Instruction set– Assembly Language Programming– Maximum mode and Minimum mode. Coprocessor, Closely coupled and Loosely Coupled multiprocessor configurations.

UNIT-III	**INTERFACING I/O AND PERIPHERALS**	**9**

Introduction to IO – Programmable peripheral interface (8255)–Programmable Timer/controller (8253) –Keyboard /display controller (8279) – Serial communication interface (8251) – D/A and A/D Interface– DMA controller (8257)– Programmable Interrupt controller (8259).

UNIT-IV	**THE 8051 MICROCONTROLLERS**	**9**

8051 Architecture– Instruction sets and Addressing modes - Special Function Registers (SFRs) - I/O Pins / Ports - 8051 Modes and Programming – Timer, Interrupts, Serial ports –Case study –Stepper motor& traffic light control.

UNIT-V	**ADVANCED PROCESSORS AND CONTROLLERS**	**9**

Arduino – Features – Architecture and Applications, PIC - Features – Architecture and Applications.

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course, students will be able to

- Understand and program the 8085 microprocessors.
- Write assembly language programs for 8086 microprocessors.
- Design and program IO Interface devices for the microprocessors.
- Analyze and program the 8051 microcontrollers for its applications.
- Interpret PIC and Arduino usage and its applications.

Text Books:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Sixth edition, Penram International Publishing, 2012.
2. A.K. Ray, K.M. Bhurchandi, - Advanced Microprocessor and Peripherals, Second edition, Tata McGraw-Hill, 2010.
3. Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.

Reference Books / Web links:

1. DoughlasV.Hall, "Microprocessors and Interfacing, Programming and Hardware", TMH, 2012
2. Kenneth J. Ayala, "The 8086 Microprocessor: Programming & Interfacing the PC", Delmar Publishers, 2007.
3. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System design using 8085, 8086, 8051 and 8096, PHI, 2007, Seventh Reprint, 2011

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19401.1	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19401.2	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19401.3	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19401.4	3	3	3	2	1	1	1	1	2	2	3	3	3	3	3
EC19401.5	3	3	2	3	2	1	1	1	2	2	3	3	2	3	3
Average	3	3	2.8	2.2	1.2	1	1	1	2	2	3	3	2.2	3	3

Subject Code	Subject Name	Category	L	T	P	C
EC19402	COMMUNICATION THEORY	PC	3	0	0	3

Objectives: The student should be made

- To introduce the concepts of Amplitude modulation and demodulation with spectral characteristics
- To learn the concepts of Angle modulation
- To understand the properties of random process
- To know the effect of noise on communication systems
- To understand the concepts of source coding techniques

UNIT-I **AMPLITUDE MODULATION** **9**

Amplitude Modulation-DSBFC, DSBSC, SSB, VSB, Modulation index, Spectra, Power relations and Bandwidth, AM Generation – Square law modulator, DSBSC Generation–Balanced modulator and Ring Modulator, SSB Generation – Filter method and Phase Shift method, VSB Generation – Filter Method, Demodulation-DSBFC-Envelope detector, DSBSC-coherent detector & Costas receiver and SSB-SC-Coherent detector, Pre-envelope & complex envelope–Comparison of different AM techniques, Superheterodyne Receiver, Frequency Division Multiplexing.

UNIT-II **ANGLE MODULATION** **9**

Phase and frequency modulation, Narrow Band and Wide band FM – Modulation index, Spectra and Transmission Bandwidth – FM modulation–Direct and Indirect methods, FM Demodulation – FM to AM conversion, FM Discriminator – PLL as FM Demodulator, Super heterodyne FM Receiver.

UNIT - III **RANDOM PROCESS** **9**

Random variables, Random Process, Stationary Processes, Mean &Correlation functions, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random Process Through a LTI filter.

UNIT-III **NOISE CHARACTERIZATION** **9**

Noise sources and types, Noise figure in cascaded amplifiers-Frii's formula, noise temperature, Narrow band noise, Representation of narrow band noise in terms of In-phase and quadrature components, Noise performance in AM systems-DSBFC, DSBSC, Noise performance in FM system, Pre-emphasis and De-emphasis, Capture effect.

UNIT-V **INFORMATION THEORY** **9**

Measure of Information, Entropy, Source coding theorem - Shannon-Fano codes& Huffman codes, Discrete Memoryless channel, Mutual information, Channel Capacity, Shannon-Hartley theorem.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- describe the principles of various Amplitude modulation and demodulation techniques and bandwidth requirement
- explain the principles of angle modulation techniques
- describe random process
- compare noise performance on AM and FM systems
- Apply the various source coding techniques on communication systems

Text Books:

1. Simon Haykin, "Communication Systems", 3rd Edition John Wiley & sons, 2001.

Reference Books / Web links:

1. Dennis Roddy &John Coolen, "Electronic Communications" 4th Edition, Pearson Education, 2008.
2. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", 2nd Edition, Pearson Education, 2006.
3. B.P.Lathi, "Modern Digital and Analog Communication Systems", 3rd Edition, Oxford University Press, 2007.
4. H P Hsu, Schaum Outline Series - "Analog and Digital Communications" Tata McGraw Hill, 2006.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19402.1	3	3	1	3	2	2	2	-	2	2	2	2	3	3	2
EC19402.2	3	2	2	2	1	2	2	-	2	1	2	2	3	3	2
EC19402.3	3	2	2	2	1	2	1	3	2	1	1	2	2	3	3
EC194024	3	2	2	2	1	2	2	2	2	1	1	2	2	2	2
EC19402.5	3	2	1	3	1	1	1	-	2	-	1	2	3	2	2
Average	3	2.2	1.6	2.4	1.2	1.8	1.6	1	2	1	1.4	2	2.6	2.6	2.2

Subject Code	Subject Name	Category	L	T	P	C
EC19441	ANALOG CIRCUITS- II	PC	3	0	2	4

Objectives: The student should be made

- To study the characteristics of OP-AMP
- To understand the functioning of OP-AMP and design OP-AMP based circuits
- To learn the applications of analog multipliers and PLL
- To study OP-AMP based ADC and DAC
- To gain knowledge on special function ICs

UNIT-I OPERATIONAL AMPLFIER AND ITS CHARACTERISTICS **9**

Introduction, ideal op-amp, Op-amp-internal circuit, DC and AC characteristics, slew rate, frequency compensation techniques.

UNIT-II APPLICATIONS OF OPERATIONAL AMPLFIER **9**

Inverting, non-inverting and differential amplifiers, Instrumentation amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger, comparator and their applications, oscillators and multivibrators. Active filters: Low pass, high pass, band pass and band stop, design guidelines.

UNIT-III ANALOG MULTIPLIER AND PLL **9**

Analog Multiplier using Emitter Coupled Transistor pair, Gilbert Multiplier cell, Operation of the basic PLL, closed loop analysis, Voltage controlled oscillator, application of PLL for AM detection, FM detection, FSK modulator and demodulator, Frequency synthesizers.

UNIT-IV DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS **9**

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, Analog to-digital converters (ADC): Single slope, dual slope, successive approximation, flash.

UNIT-V SPECIAL FUNCTION ICs **9**

Timer IC 555, IC Voltage regulators: Three terminal fixed and Adjustable voltage regulators, IC 723 general purpose regulator, Monolithic switching regulator.

Contact Hours : 45

List of Experiments

1.	Inverting, non-inverting and differential amplifiers using OPAMP (or) Instrumentation amplifier
2.	Integrator and differentiator using OPAMP
3.	Active low pass, high pass and band pass filter using op-amp (any 2)
4.	Astable, monostable multivibrator and Schmitt trigger using op-amp
5.	(a) RC phase shift (or) Wien bridge oscillator using op-amp
	(b) Astable (or) monostable multivibrator using IC 555 timer
6.	(a) R-2R Ladder DAC
	(b) DC power supply using LM317 (or) LM723
	P-SPICE Simulation of:
7.	(a) Multivibrators and Schmitt Trigger Circuit
	(b) Low pass, high pass (or) band pass, band stop active filters
	Contact Hours

Contact Hours : 30

Total Contact Hours : 75

Course Outcomes: On completion of the course, the students will be able to

- Describe the op-amp characteristics
- Analyse and design OP-AMP based circuits
- Implement ADC and DAC
- Design Analog multipliers and PLL
- Design and demonstrate the performance of Multivibrators and Power supplies

Text Books:

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007

Reference Books:

1. Adel.S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", 6th Edition, Oxford University Press, 2010.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2007.
3. Paul Gray, Hurst, Lewis, Meyer "Analysis and Design of Analog Integrated Circuits", 4th Edition, John Willey& Sons 2005
4. Millman.J. and Halkias C.C, "Integrated Electronics", McGraw Hill, 2001.
5. Analog Electronics, L.K. Maheshwari, Laxmi Publications

6	J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
7	P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
8	Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition
9	J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
Web links for virtual lab:	
1	http://www.vlab.co.in/ba-nptel-labs-electronics-and-communications
2	https://www.circuitlab.com/

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
EC19441.1	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**
EC19441.2	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**
EC19441.3	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**2**
EC19441.4	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
EC19441.5	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
Average	**3**	**2**	**2**	**1.6**	**2**	**1**	**1**	**1**	**2.4**	**1.4**	**1.8**	**2**	**2**	**2**	**2**

Subject Code	Subject Name	Category	L	T	P	C
	OPEN ELECTIVE-I	**OE**				3

Subject Code	Subject Name	Category	L	T	P	C
EC19411	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	PC	0	0	4	2

Objectives: The student should be made

- To Introduce ALP concepts, features of 8085
- To learn ALP concepts for arithmetic and logical operations in 8086
- To understand ALP concepts for arithmetic and logical operations in 8051
- To Interface different I/Os with Microprocessors and Microcontrollers
- To familiar with MASM

List of Experiments

	8085 Microprocessor - Writing and executing 8085 Program to realize basic operations
1	8-bit Arithmetic Operations
2	Searching an array of numbers
3	Code conversion
4	Decimal Arithmetic Operations
	Peripherals and Interfacing using 8085 Processor
5	8255 - Parallel interface
6	8253– Timer interface
	8086 Microprocessor- Writing and executing 8085 Program to realize basic operations
7	16-bit Arithmetic Operations
8	Logical operations
9	String manipulations
	8086 Programs using MASM
10	Display a message
11	Password checking
	Interface peripheral IO to 8086 system board
12	8279 - Key board and Display Controller
13	Analog to Digital converter interface
14	Digital to Analog converter interface.
15	8251-Serial Interface
	8051 Microcontroller
16	8 bit Arithmetic Operation
17	Stepper Motor Control
18	Object distance calculation using Ultra sound transceiver.
	MINI PROJECT
19	Microcontroller based Mini projects
	Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- Write Assembly-language program to perform basic operations using 8085 Microprocessor.
- Compose Assembly-language program to perform basic operations using 8086 Microprocessor.
- Perform Assembly-language program to perform basic operations using 8051 Microcontroller.
- Code and Interface various peripherals with 8085, 8086 and 8051.
- Develop project for different applications using advanced Microcontrollers.

References

1	Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Sixth edition, Penram International Publishing, 2012.
2	A.K. Ray, K.M. Bhurchandi, - Advanced Microprocessor and Peripherals, Second edition, Tata McGraw-Hill, 2010.
3	Mohamed Ali Mazidi, Janice Gillispie Mazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19411.1	3	2	1	1	2	1	1	1	1	1	1	1	1	1	1
EC19411.2	3	2	1	1	2	1	1	1	1	1	1	1	1	1	1
EC19411.3	3	2	1	1	2	1	1	1	1	1	1	1	1	1	1
EC19411.4	3	3	2	2	3	1	1	1	2	1	2	2	2	2	2

EC19411.5	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**3**
Average	**3**	**2.4**	**1.6**	**1.6**	**2.4**	**1.2**	**1**	**1**	**1.4**	**1**	**1.4**	**1.4**	**1.6**	**1.6**	**1.6**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
GE19421	**SOFT SKILLS-I**	**EEC**	**0**	**0**	**2**	**1**

Objectives: The student should be made

- To help students break out of shyness
- To build confidence
- To enhance English communication skills
- To encourage students' creative thinking to help them frame their own opinions

Learning and Teaching Strategy: The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the student's ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to stand-up in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought

			process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Outcomes: On completion of the course, the students will be able to

- Be more confident
- Speak in front of a large audience
- Be better creative thinkers
- Be spontaneous
- Know the importance of communicating in English

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19421.1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
GE19421.2	1	-	-	-	-	-	1	-	1	3	1	1	-	-	-
GE19421.3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
GE19421.4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
GE19421.5	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-
Average	0.2	0	0	0	0	0	0.2	0	0.4	3	0.2	0.4	0	0.2	0.6

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
CS19411	PYTHON PROGRAMMING FOR MACHINE LEARNING (with effect from 2021 batch onwards) Common to all branches of B.E / B.Tech programmes (except – CSE, CSBS, CSD, IT, AI/ML)	ES	1	0	4	3

Course Objectives:

- To understand the relationship of the data collected for decision making.
- To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- To lay the foundation of machine learning and its practical applications.
- To develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- To prepare for real-time problem-solving in data science and machine learning.

List of Experiments

1. NumPy Basics: Arrays and Vectorized Computation
2. Getting Started with pandas
3. Data Loading, Storage, and File Formats
4. Data Cleaning and Preparation
5. Data Wrangling: Join, Combine, and Reshape
6. Plotting and Visualization
7. Data Aggregation and Group Operations
8. Time Series
9. Supervised Learning
10. Unsupervised Learning
11. Representing Data and Engineering Features
12. Model Evaluation and Improvement

Contact Hours : 75

Course Outcomes:

On completion of the course, the students will be able to:

- Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
- Use appropriate packages for analysing and representing data.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Apply various machine learning algorithms in a range of real-world applications.

Text Books:

1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc, 2017.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

Reference Books:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CS19411.1	2	2	2	2	1	0	0	0	1	2	0	1	3	3	3
CS19411.2	2	2	1	1	2	0	0	0	0	0	0	1	2	1	3
CS19411.3	2	3	2	1	2	0	0	0	1	1	0	1	2	3	2
CS19411.4	1	1	1	0	1	0	0	0	0	1	1	0	1	2	3
CS19411.5	3	3	2	3	3	0	0	0	2	1	0	1	2	3	3
Average	**2**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**2**	**2**	**3**

SEMESTER V

Subject Code	Subject Name	Category	L	T	P	C
EC19501	DIGITAL SIGNAL PROCESSING	PC	2	1	0	3

Objectives:

- To study about the DFT for spectral analysis
- To understand the FFT and its applications in linear filtering
- To design IIR filters and analyse its characteristics.
- To construct FIR filters and analyse its characteristics.
- To study the various quantization effects due to finite word length

UNIT-I	DISCRETE FOURIER TRANSFORM	9

DFT& IDFT, Use of DFT in linear and circular convolution, auto-correlation and cross correlation. Filtering of long data sequence – Overlap add and overlap save methods.

UNIT-II	FAST FOURIER TRANSFORM	9

DFT using radix-2 FFT algorithms - Decimation in time algorithm and Decimation in frequency algorithm. IDFT using FFT algorithms. Use of FFT in linear filtering – DCT

UNIT-III	INFINITE IMPULSE RESPONSE FILTERS	9

Characteristics of practical frequency selective filters – Characteristics of Analog Butterworth Filters and Chebyshev Type – I Filters (Up to 3rd Order) (LPF, HPF, BPF, BSF) – Design of digital filter using impulse invariance technique and Bilinear Transformation.

UNIT-IV	FINITE IMPULSE RESPONSE FILTERS	9

Design of Linear phase FIR filters using Fourier series method – FIR filter design using windows (Rectangular, Hamming, Hanning window, and Blackman), Frequency sampling method

UNIT-V	FINITE WORD LENGTH EFFECTS	9

Fixed point and floating-point number representation – quantisation – truncation and rounding – quantisation noise (input / output quantisation error, coefficient quantisation error, product quantisation error) – overflow error – limit cycle oscillations due to product quantization and summation – scaling to prevent overflow

Total Contact Hours	:	45

Course Outcomes: On completion of course, students will be able to

- Apply DFT for the analysis of digital signals & systems
- Perform frequency transforms for linear filtering using FFT
- Design digital IIR filters for any given specifications and applications
- Design digital FIR Filters for any given specifications and applications
- Understand the quantisation process in finite word length

Text Books:

1. John G.Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Fourth Edition, Pearson Education / Prentice Hall, 2007
2. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Third Edition, Tata McGraw Hill, 2011.

Reference Books / Web links:

1. Emmanuel C.Ifeachor, & Barrie.W.Jervis, “Digital Signal Processing”, Second edition, Pearson Education / Prentice Hall, 2002
2. Alan V.Oppenheim, Ronald W. Schafer &Hohn. R.Back, “Discrete Time Signal Processing”, third edition, Pearson Education, 2014.
3. Andreas Antoniou, “Digital Signal Processing-Signals, Systems and Filters”, Edition 2006, Tata McGraw Hill.
4. Digital Signal Processing - S.Salivahanan, A.Vallavaraj, C.Gnanapriya, 2nd Edition The McGraw-Hill, 2000.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19501.1	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**
EC19501.2	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**
EC19501.3	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**
EC19501.4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**
EC19501.5	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**
Average	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**2**

Subject Code	Subject Name	Category	L	T	P	C
EC19502	CONTROL SYSTEM ENGINEERING	PC	2	1	0	3

Objectives: The student should be made

- To understand the elements of control system and their modeling using various techniques
- To learn time response analysis of various systems
- To study the frequency response characteristics of the systems
- To depict different methods for stability analysis
- To introduce the state variable analysis for CT and DT systems

UNIT-I **CONTROL SYSTEM MODELING** **10**

Basic elements of Control System, Open loop and Closed loop systems, Differential equation, Transfer function, Modeling of Electrical and Mechanical systems, Block diagram reduction techniques, Signal flow graph. Automatic control systems- Temperature control systems, Servomechanism process control.

UNIT-II **TIME RESPONSE ANALYSIS** **8**

Time response analysis - first order systems, Impulse and Step response analysis of second order systems, Steady state errors, P, PI, PD and PID Controllers.

UNIT-III **FREQUENCY RESPONSE ANALYSIS** **10**

Frequency Response analysis - Bode Plot, Polar Plot, Constant M & N circles, Compensators (Qualitative Approach) - Lead, Lag, and Lead-Lag.

UNIT-IV **STABILITY ANALYSIS** **9**

Stability analysis – Routh Array, Hurwitz criterion, Root Locus technique - construction of Root Locus, dominant Poles, Nyquist Stability criterion-Relative Stability.

UNIT-V **STATE VARIABLE ANALYSIS** **8**

State space representation of Continuous Time systems, State equations, Transfer function from state variable representation, Solutions of the state equations, Concepts of Controllability and Observability, Introduction to State space representation for Discrete time systems.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Compute the transfer function of different physical systems.
- Examine the time domain specifications and calculate the steady state error.
- Illustrate the frequency response characteristics of systems.
- Determine the stability of systems using Routh-Hurwitz, Nyquist stability and Root Locus technique.
- Analyze the state space model of continuous and discrete systems.

Text Books:

1 J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 5th Edition, 2007.

Reference Books / Web links:

1 Benjamin.C.Kuo, “Automatic control systems”, Prentice Hall of India, 7th Edition, 1995.

2 M.Gopal, “Control System – Principles and Design”, Tata McGraw Hill, 2nd Edition, 2006.

3 Schaum‟s Outline Series, “Feedback and Control Systems” Tata Mc Graw-Hill, 2007.

4 Joseph J. DiStefano, Allen R. Stubberud, Schaum's Outline of ―Feedback and Control Systems, McGraw-Hill Education; 2nd edition 2013.

5. S.K.Bhattacharya, “Control Systems Engineering”Pearson Education, 2012

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19502.1	3	3	3	2	1	1	1	1	1	1	1	1	3	3	2
EC19502.2	3	3	3	2	3	2	2	1	1	2	1	2	3	3	2
EC19502.3	3	3	3	3	3	2	2	1	1	2	1	2	3	3	2
EC19502.4	3	3	3	3	3	2	2	1	1	2	1	2	3	3	2
EC19502.5	3	3	3	3	3	3	2	1	1	2	1	3	3	3	2
Average	3	3	3	2.6	2.6	2	1.8	1	1	1.8	1	2	3	3	2

Subject Code	Subject Name	Category	L	T	P	C
EC19503	EM WAVES AND WAVEGUIDES	PC	2	1	0	3

Objectives: The student should be made

- To understand the basics of static electric field and the associated laws.
- To attain knowledge on the basics of static magnetic field and Maxwell's equation.
- To study the waves in homogeneous medium.
- To learn the reflection and refraction of plane waves.
- To acquire knowledge on waves between parallel planes and in rectangular guides.

UNIT-I STATIONARY ELECTRIC FIELDS **9**

Coulomb's law and field intensity, Electric flux density, Gauss's law, Applications of Gauss law for point and infinite line charge distributions, Electric potential, Relationship between E and V, an electric dipole.
Boundary conditions for dielectric-dielectric interface. Poisson's and Laplace equation. Capacitance, Capacitance of various geometries using Laplace equations.

UNIT-II STATIONARY MAGNETIC FIELDS & MAXWELL'S EQUATION **9**

Biot-Savart Law, Magnetic field Intensity, Magnetic flux and magnetic flux density, Estimation of Magnetic field intensity for finite straight conductor. Ampere's circuital law, Application of Ampere's law on infinitely long coaxial transmission line. Scalar and Vector magnetic potentials. Inductance of Solenoid and Toroid. Magnetic boundary condition. Integral and differential form of Maxwell's equation.

UNIT-III ELECTROMAGNETIC WAVES IN A HOMOGENOUS MEDIUM (Qualitative only) **9**

Constitutive relations, Solution for free-space conditions, Uniform plane-wave propagation, Uniform plane waves, Relation between E and H in a uniform plane wave, Wave equation for a conducting medium, Wave propagation in lossless medium, Wave propagation in a conducting medium.
Conductors and dielectrics, Wave propagation in good dielectric, Wave propagation in good conductor, Depth of penetration, Polarization of uniform plane wave.

UNIT-IV REFLECTION AND REFRACTION OF PLANE WAVES (Qualitative only) **9**

Reflection by a perfect conductor – Normal incidence. Reflection by a perfect conductor – Oblique incidence, E perpendicular to the plane of incidence, E parallel to the plane of incidence. Reflection by a perfect dielectric – Normal incidence. Reflection by a perfect insulator – Oblique incidence, perpendicular polarization, parallel polarization, Snell's law, Brewster angle, Total internal reflection.
Poynting's Theorem. Power flow for a plane wave, Power flow in a concentric cable. Instantaneous, average and complex Poynting vector.

UNIT-V WAVEGUIDES (Qualitative only) **9**

Waves between parallel planes, Transverse electric waves, Transverse magnetic waves, Characteristics of TE and TM waves.
Rectangular guides, Transverse magnetic waves in rectangular guides, Transverse electric waves in rectangular guides, Propagation parameters in rectangular guides.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Describe electro-static theory and apply them for modelling and analysis of capacitors
- Explain magneto-static theory for modelling and analysis of inductors
- Characterize uniform plane wave and its propagation in various media
- Analyse the reflection and refraction of waves at media interface
- Evaluate the field components, wave impedance and characteristic parameters when TE, TM propagate between parallel planes and in rectangular guides

Text Books:

1 Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4th Edition, Oxford University Press Inc., First Indian edition, 2009.

2 E.C.Jordan and K.G. Balmain, 'Electromagnetic Waves and Radiating Systems', Prentice Hall of India, 2006.

3 R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005.

4 Narayana Rao, N: Engineering Electromagnetics, 3rd edition, Prentice Hall, 1997.

5	Ramo, Whinnery and Van Duzer: "Fields and Waves in Communications Electronics" John Wiley & Sons, 3rd edition 2003.
6	David Cheng, Electromagnetics, Prentice Hall.
7	G.S.N Raju, 'Electromagnetic Field Theory and Transmission Lines' Pearson Education, First edition, 2005.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19503.1	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**1**
EC19503.2	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**1**
EC19503.3	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
EC19503.4	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**
EC195035	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**1**
Average	**3**	**2**	**2**	**1.6**	**1**	**1**	**1**	**1**	**1.6**	**1**	**1**	**1.6**	**2**	**2**	**1**

Subject Code	Subject Name	Category	L	T	P	C
EC19504	DIGITAL COMMUNICATION	PC	3	0	0	3

Objectives: The student should be made

- To understand the functional components and principles of digital communication system
- To study the various waveform coding schemes
- To learn the various baseband schemes and its effect on signal transmission
- To understand the various Band pass signalling schemes
- To know the fundamentals of error control coding schemes

UNIT-I QUANTIZATION AND PULSE MODULATION **9**

Review of Low pass Sampling, Aliasing, Signal reconstruction - Quantization - Uniform & non-uniform quantization - Quantization noise - Logarithmic companding of speech signal - Overview of PAM, PWM and PPM.

UNIT-II WAVEFORM CODING **9**

PCM - DPCM -ADPCM - Delta modulation - ADM - Linear Predictive Coding ,Line codes and its properties – TDM.

UNIT-III BASEBAND TRANSMISSION&RECEPTION **9**

ISI - Nyquist criterion for distortion less transmission - Pulse shaping - Eye pattern - Correlative coding – M-ary schemes - Correlation receiver – Matched filter receiver - Adaptive equalization, LMS algorithm.

UNIT-IV DIGITAL MODULATION SCHEMES &SPREAD SPECTRUM TECHNIQUES **9**

Generation, detection and BER analysis of coherent BPSK, BFSK, QPSK, QAM - Carrier Synchronization - Structure of Non-coherent Receivers - Generation and detection of BFSK, DPSK - Spread spectrum - PN sequences, Direct Sequence and Frequency Hopping Spread Spectrum systems.

UNIT-V ERROR CONTROL CODING **9**

Channel coding theorem - Linear Block Codes - Hamming codes - Cyclic codes - Convolutional codes and Viterbi decoding.

Contact Hours : 45

Course Outcomes: On completion of the course, the students will be able to

- Classify the blocks in a design of digital communication system
- Describe the various waveform coding schemes
- Interpret the various baseband transmission schemes
- Analyze the error performance of various Band pass signaling schemes
- Evaluate various error control coding schemes

Text Books:

1. Simon Haykin, "Digital Communications", John Wiley, 2015.

Reference Books:

1. B. Sklar, “Digital Communication Fundamentals and Applications”, 2nd Edition, Pearson Education, 2009.
2. H P Hsu, Schaum Outline Series - “Analog and Digital Communications”, TMH 2006.
3. J.G Proakis, "Digital Communication", Tata Mc Graw Hill Company, 5th Edition, 2008.
4. B.P.Lathi, -Modern Digital and Analog Communication Systems‖ 3rd Edition, Oxford University Press 2007.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19504.1	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2
EC19504.2	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2
EC19504.3	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2
EC19504.4	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2
EC19504.5	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2
Average	3	3	1	3	3	1	1	1	1	3	3	3	3	3	2

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-I	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-II	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
EC 19511	**DIGITAL SIGNAL PROCESSING LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives:

- To implement convolution and correlation
- To analyse the spectrum of signals
- To design IIR & FIR filters
- To demonstrate various MAC operations using DSP processor
- To perform convolution and wave generation using DSP processor

List of Experiments

MATLAB / EQUIVALENT SOFTWARE PACKAGE

1	Generation of sequences
2	Linear Convolution and Circular Convolution
3	Auto Correlation and Cross Correlation
4	Spectrum analysis using DFT
5	IIR filter design-Butterworth approximation (LPF, HPF, BPF & BSF)
6	IIR filter design-Chebyshev approximation (LPF, HPF, BPF & BSF)
7	FIR filter design -Rectangular, Hanning& Hamming (LPF, HPF, BPF & BSF)
8	Multirate processing (upsampling and downsampling)

DSP PROCESSOR BASED IMPLEMENTATION

9	MAC operation using various addressing modes
10	Linear Convolution
11	Circular Convolution
12	Waveform generation

Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- Carry out simulation of signals
- Design IIR and FIR filters
- Analyze spectrum of digital signals
- Demonstrate the applications of DFT
- Demonstrate their abilities towards DSP processor-based implementation of DSP systems

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
EC 19511.1	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2
EC 19511.2	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2
EC 19511.3	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2
EC 19511.4	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2
EC 19511.5	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2
Average	3	3	3	3	3	2	1	2	2	2	1	2	3	3	2

Subject Code	Subject Name	Category	L	T	P	C
EC19512	COMMUNICATION SYSTEMS LABORATORY	PC	0	0	4	2

Objectives: The student should be made to

- To visualize the effects of sampling and TDM
- To Implement and classify AM & FM modulation and demodulation
- To implement PCM & DM
- To simulate and compare Digital Modulation schemes
- To simulate Equalization algorithms

List of Experiments

1	Signal Sampling and reconstruction
2	Time Division Multiplexing
3	AM Modulation and Demodulation
4	FM Modulation and Demodulation
5	Pulse Code Modulation and Demodulation
6	Delta Modulation and Demodulation
7	Line coding schemes
8	Simulation of BPSK, BFSK, QPSK, and DPSK schemes
9	Simulation of LMS and Zero forcing algorithms
10	Simulation of Error control coding schemes

Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- Simulate & validate the various functional modules of a communication system
- Understand the various waveform coding schemes
- Interpret the Digital baseband transmission methods
- Demonstrate their knowledge in base band signalling schemes
- Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication system

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
EC19512.1	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2
EC19512.2	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2
EC19512.3	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2
EC19512.4	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2
EC19512.5	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2
Average	3	3	2	3	3	1	1	1	3	3	3	3	3	3	2

Subject Code	Subject Name	Category	L	T	P	C
GE19521	SOFT SKILLS-II	EEC	0	0	2	1

Objectives: The student should be made to

- To help students break out of shyness.
- To build confidence
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions
- To help students break out of shyness.

Course Description: The course, **"VAP"** intends to enhance the students' confidence to communicate in front of an audience effectively. The emphasis is on improving the spoken skills of the students so that they can communicate both, in the college and in the corporate setting to deliver their message successfully. In today's technology driven world, communicating with confidence is imperative. Hence, this course aims at providing students with the necessary practice in the form of debates, discussions and role plays.

Program Learning Goals: This program will help our students to build confidence and improve their English communication in order to face the corporate world as well as providing them with opportunities to grow within an organisation.

Learning and Teaching Strategy: The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.

7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
13.	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Outcomes: On completion of the course, the students will be able to

●	Be more confident
●	Speak in front of a large audience without hesitation
●	Think creatively
●	Speak impromptu
●	Communicate in English

PO/PSO / CO	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
GE19521.1	-	-	-	-	-	-	-	-	2	3	1	1	-	-	2
GE19521.2	-	-	-	-	-	-	-	-	2	3	2	-	-	-	2
GE19521.3	-	1	-	-	-	-	-	-	2	3	1	1	-	2	3
GE19521.4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	1
GE19521.5	-	1	-	-	-	-	-	-	2	3	1	1	-	1	3
Average	0	0.4	0	0	0	0	0	0	2	3	1.25	1	0	1.5	2.2

SEMESTER VI

Subject Code	Subject Name	Category	L	T	P	C
EC19601	ANTENNA THEORY	PC	3	0	0	3

Objectives:

- To give insight into the transmission lines
- To give insight into the radiation phenomena of antenna
- To give a thorough understanding of the radiation characteristics of antenna arrays
- To make them understand various aperture and slot antennas used in practical applications
- To give insight into advanced antennas used in special applications

UNIT-I	INTRODUCTION TO TRANSMISSION LINE THEORY	9

The transmission line: General solution-The infinite line-Wavelength, Velocity of Propagation-Waveform distortion- The distortion-less line-Reflection Coefficient-Standing waves, Nodes, Standing Wave Ratio-Line calculation-Input and transfer impedance-Open and Short circuited lines-The quarter-wave line.

UNIT-II	FUNDAMENTALS OF RADIATION	9

Antenna parameters - Radiation pattern, Gain, Directivity, Effective aperture, Radiation Resistance, Bandwidth, Beam width, Polarization, Polarization Mismatch-Polarization loss factor and efficiency, Antenna noise temperature, Radiation from oscillating dipole, half wave dipole, folded dipole and Yagi-Uda array.

UNIT-III	ANTENNA ARRAYS	9

Two element array, N-element linear array, Pattern multiplication, Broadside and end fire array, Phased arrays, Adaptive array and Smart antennas, Binomial array.

UNIT-IV	APERTURE AND SLOT ANTENNAS	9

Huygens' principle, Horn antenna, Reflector antenna-Aperture blockage, Feeding structures, Slot antennas- Babinet's principle, Microstrip antennas – Radiation mechanism, Feeding methods, Applications.

UNIT-V	SPECIAL ANTENNAS AND MEASUREMENTS	9

Principle of frequency independent antennas -Spiral antenna, Helical antenna, Log periodic dipole array. **Modern Antennas:** Wearable antennas, Reconfigurable antennas. **Measurements:** Measurement of Gain, Radiation pattern, VSWR.

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Comprehend and appreciate the significance and role of this course in the present contemporary world.
- Understand the fundamentals of transmission lines.
- Understand the fundamentals of antennas by gaining knowledge in radiation mechanism.
- Have insight into the radiation phenomena in antenna arrays.
- Have a thorough understanding of the radiation characteristics of different types of modern antennas.

Text Books:

1. John D Ryder, "Networks, lines and fields", 2nd Edition, Pearson Education India, 2015.
2. John D Kraus, Ronald J Marhefka, Ahmed S Khan, "Antennas and Wave Propagation", McGraw Hill, 5th Edition, 2017.
3. Constantine A Balanis, "Antenna Theory Analysis and Design", Wiley India, 4th Edition, 2016.

Reference Books / Web links:

1. R.E.Collin, "Antennas and Radio wave propagation", McGraw Hill, 1985.
2. G.S.N Raju, "Electromagnetic Field Theory and Transmission lines", Pearson Education, First edition, 2005.
3. S. Drabowitch, "Modern Antennas", Springer Publications, 2nd Edition, 2007.
4. Robert S.Elliott, "Antenna theory and Design", Wiley student edition, 2010
5. Debatosh Guha and Yahia M.M. Antar, "Microstrip and Printed Antennas-New Trends, Techniques and Applications", A John Wiley and sons, 2011.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19601.1	1	1	1	1	-	1	1	-	1	1	3	3	2	1	-
EC19601.2	3	3	3	3	-	1	1	1	1	1	1	1	2	1	1
EC19601.3	3	3	3	3	2	1	1	1	2	1	1	1	2	1	1

EC19601.4	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**2**
EC19601.5	**2**	**3**	**3**	**2**	**-**	**1**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**-**
Average	**2.4**	**2.6**	**2.6**	**2.2**	**2**	**1**	**1.8**	**1.5**	**1.6**	**1.4**	**1.4**	**1.4**	**2**	**1**	**1.33**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19602	**WIRELESS COMMUNICATION**	**PC**	**3**	**0**	**0**	**3**

Objectives: The student should be made

- To know the characteristic of wireless channel
- To Learn the various cellular architectures
- To Understand the concepts behind various digital signalling schemes for fading channels
- To Be familiar the various multipath mitigation techniques
- To analyse the various multiple antenna systems

UNIT-I **WIRELESS CHANNELS** **9**

Large scale path loss – Path loss models: Free space and Two-Ray models -Outdoor propagation models – Okumura Model, COST 231-Link budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters- Coherence bandwidth – Doppler spread &coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading, Practical illustration of wireless channel behaviour.

UNIT-II **CELLULAR ARCHITECTURE** **9**

Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- handoff- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.

UNIT-III **DIGITAL SIGNALING FOR FADING CHANNELS** **9**

Structure of a wireless communication link, Principles of offset-QPSK, $\pi/4$-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, OFDM principle – cyclic prefix, PAPR–Transceiver-Case study-IEEE 802.11 physical layer design using OFDM.

UNIT-IV **MULTIPATH MITIGATION TECHNIQUES** **9**

Equalization – Adaptive equalization, Linear and non-Linear equalization, Zero forcing and LMS algorithms. Diversity – Micro and Macro diversity – transmitter diversity, receiver diversity, Error probability in fading channels with diversity reception, Rake receiver.

UNIT-V **MULTIPLE ANTENNA TECHNIQUES** **9**

MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming- Channel state information-capacity in fading and non-fading channels, Relevance to upcoming wireless communication technologies and applications.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Characterize the mathematical model of wireless channels
- Describe the cellular concept of wireless communication system
- Design and implement various signalling schemes for fading channels
- Analyse and compare the performance of multipath mitigation techniques
- Design and implement systems with transmit/receive diversity and MIMO systems and analyze their performance

Text Books:

1 Rappaport,T.S., "Wireless communications", Second Edition, Pearson Education, 2010.

2 Andreas.F. Molisch, "Wireless Communications", Second edition, John Wiley – India,2011.

3 Simon Hayin, Michael Moher,"Modern Wireless Communication" , Pearson Education,2011.

Reference Books / Web links:

1 David Tse and PramodViswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.

2 UpenaDalal, " Wireless Communication", Oxford University Press, Edition 4,2009.

3 Van Nee, R. and Ramji Prasad, "OFDM for wireless multimedia communications", Artech House, 2000.

4 Andreas Goldsmith, Wireless Communications, Cambridge University Press, 2007.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19602.1	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**-**	**1**	**3**	**2**	**2**	**3**	**2**	**2**
EC19602.2	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**1**	**-**	**3**	**-**	**2**	**3**	**3**	**2**
EC19602.3	**3**	**3**	**1**	**3**	**3**	**1**	**1**	**1**	**-**	**2**	**2**	**2**	**1**	**2**	**2**
EC19602.4	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**-**	**2**	**-**	**2**	**3**	**2**	**2**
EC19602.5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**2**
Average	**3**	**3**	**2.4**	**2.8**	**2.6**	**1.8**	**1.8**	**1**	**1.5**	**2.4**	**2**	**2.2**	**2.6**	**2.2**	**2**

Subject Code	Subject Name	Category	L	T	P	C
EC19641	VLSI DESIGN	PC	3	0	2	4

Objectives: The student should be made

- Study the fundamentals of CMOS circuits and its characteristics.
- Realization of combinational & sequential digital circuits.
- Design arithmetic building blocks and Compare different FPGA architectures with testability of VLSI circuits.
- Analyze various digital circuits using HDL and verify using simulated results.
- Provide hands on to implement digital circuits with professional design (EDA) platforms.

UNIT-I	MOS TRANSISTOR PRINCIPLE	9

Introduction to MOS Transistors- Manufacturing Process in IC- Fabrication of transistors- Ideal I-V Characteristics, C-V Characteristics, Non ideal I-V Effects, DC Transfer characteristics-Propagation delay-Elmore delay, Logical Effort, Parasitic delay. CMOS Layout Design rules, Inverter layout- Stick diagram.

UNIT-II	COMBINATIONAL LOGIC CIRCUITS	9

Examples of Combinational logic design, Static CMOS-Ratioed Circuits - Pseudo nMOS, Pass Transistor Logic-CPL, Dynamic CMOS-Domino logic, Dynamic Power, Static Power.

UNIT-III	SEQUENTIAL LOGIC CIRCUITS	9

Static Latches and Registers- Multiplexer based latches, Master slave Edge triggered register, Dynamic Latches and Registers- Dynamic Transmission Gate Edge-triggered Registers, C2MOS register, Pipelining and timing issues.

UNIT-IV	DESIGNING ARITHMETIC BUILDING BLOCKS	9

Data Paths, Adders-Ripple carry adder, Multipliers-Array Multiplier, Barrel Shifters, Memory Architectures and Building Blocks.

UNIT-V	IMPLEMENTATION STRATEGIES AND TESTING	9

Introduction to FPGA and HDL -ASIC Design-Full-Custom design and Semi-Custom design- FPGA building block architectures. Design for Testability: Ad Hoc Testing, Scan Design.

Contact Hours	:	45

List of Experiments (Based on HDL and FPGA)

1	Design an Arithmetic circuits (Adder and multiplier) using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
2	Design counters using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
3	Design a PRBS generators using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.

List of Experiments (Based on Cadence/Mentor Graphics/Tanner/equivalent EDA Tools)

4	Design and simulate a CMOS inverter using digital flow, Manual/Automatic Layout Generation.
5	Design and simulate CMOS basic gates.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS HARDWARE AND SOFTWARE

- Xilinx ISE/Altera Quartus/ equivalent EDA Tools along with Xilinx/Altera/equivalent FPGA Boards.
- Cadence/Synopsis/ Mentor Graphics /Tanner/equivalent EDA Tools.

Contact Hours	:	30
Total Contact Hours	:	75

Course Outcomes: Upon completion of the course, the students will be able to

- Understand the concepts of digital building blocks using MOS transistor.
- Analyze combinational and sequential MOS circuits and power strategies.
- Design and implementation of arithmetic building blocks, FPGA design flow and testing.
- Create HDL code for digital integrated circuit and Import the logic modules into FPGA Boards.
- Simulate and Extract the layouts of Digital Blocks using EDA tools.

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 ,AnanthaChandrakasan, Borivoje. Nikolic, Digital Integrated Circuits:A Design perspective‖, Second Edition , Pearson , 2016.(UNIT III,IV).
3	M J Smith, "Application Specific Integrated Circuits", Addisson Wesley, 2014.(Unit V).

Reference Books:	
1	Sung-Mo kang, Yusuf leblebici, Chulwoo Kim ―CMOS Digital Integrated Circuits: Analysis& Design‖,4th edition McGraw Hill Education,2018.
2	Wayne Wolf, ―Modern VLSI Design: System On Chip Design, Pearson Education, 2007.
3	Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010.
Web links for virtual lab:	
1	https://www.iitg.ac.in/cseweb/vlab/vlsi/
2	http://cse14-iiith.vlabs.ac.in/List%20of%20experiments.html?domain=Computer%20Science

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19641.1	3	2	2	2	2	2	3	1	2	2	2	3	3	2	2
EC19641.2	2	3	3	2	3	3	2	1	3	3	3	3	2	3	3
EC19641.3	3	2	2	3	2	3	3	1	3	3	3	3	3	3	2
EC19641.4	3	2	3	3	3	2	2	1	3	2	3	3	2	3	3
EC19641.5	3	3	3	2	3	3	3	1	3	3	3	3	2	3	3
Average	2.8	2.4	2.6	2.4	2.6	2.6	2.6	1	2.8	2.6	2.8	3	2.4	2.8	2.6

Subject Code	Subject Name	Category	L	T	P	C
EC19642	COMMUNICATION NETWORKS	PC	3	0	2	4

Objectives: The student should be made to

- Introduce the layered communication architectures and understand various physical, data link layer protocols.
- Analyze different network protocols and routing algorithms.
- Assess transport and application layer protocols with security issues.
- Create communication between two desktop computers using Inter-networking devices using protocols and routing algorithms.
- Configure network using simulation tools.

UNIT-I	NETWORK FUNDAMENTALS AND PHYSICAL LAYER	9

Data Communication, Networks, Protocols and standards, Line configuration, Topology, Transmission mode, Signaling, RS232 Serial Communication and Manchester encoding, OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Addressing.

UNIT-II	DATA LINK LAYER	9

Error detection and correction- Types of error, CRC, Checksum, Framing, Flow control and error control, HDLC - frames. Multiple access - Random access, Controlled access, IEEE standards: - IEEE 802.3, IEEE 802.11, Bluetooth

UNIT-III	NETWORKING AND ITS DEVICES	9

Connecting Devices, Logical Addressing- IPV4, IPV6, Transition from IPV4 to IPV6, Address mapping – Basics of ARP, RARP, BOOTP and DHCP, ICMP, IGMP, Network routing algorithms- Distance vector routing and Link state routing.

UNIT-IV	TRANSPORT LAYER	9

Process-process delivery: - UDP,TCP- Features, segment, connection, Flow control, Congestion control in TCP, Quality of services.

UNIT-V	APPLICATION LAYER	9

Basics of Application protocols: DNS, HTTP, FTP and SMTP, Network management protocol: SNMP, Fundamentals of Data security: Cryptography: Asymmetric Encryption-RSA algorithm, Symmetric Encrytpion-AES algorithm.

	Contact Hours	:	45

List of Experiments

1. Implementation of Error Detection / Error Correction Techniques
2. Study of socket programming and Client – Server model – Implementation of stop and wait protocol
3. Implementation of Distance vector and Link state routing algorithm
4. Encryption and Decryption.
5. Study of Network Simulator (NS) / Configuring network using Cisco Packet Tracer configure

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS SOFTWARE

- C / C++ / Java / Equivalent Compiler
- Network simulator like NS2/ Cisco Packet Tracer
- HARDWARE Standalone desktops

	Contact Hours	:	30
	Total Contact Hours	:	75

Course Outcomes: On completion of the course, the students will be able to

- Well versed on the layered communication architectures and their interworking.
- Compare different protocols and routing algorithms for an efficient network
- Design a network for a particular application and analyze the performance of the network
- Communicate between two desktop computers and implement the different protocols using sockets and routing algorithms.
- Implement network simulation using NS

Text Books:

1. Behrouz.A. Forouzan, Data Communication and Networking, 4th Edition, Tata McGraw Hill
2. Stallings.W., Data and Computer Communication, 9th Edition, Prentice Hall of India, 2011

Reference Books:

1. Tanenboum, A.S, Computer Networks, 5th Edition, Prentice Hall Of India, 2013

2	Keshav.S. An Engineering approach to Computer Networking, Addision – Wesley, 2010.
3	J.E.Flood, Telecommunication Switching, Traffic and networks, 2nd edition, Pearson Education, 2007
4	Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers, 2011.
Web links:	
1	http://cse29-iiith.vlabs.ac.in/exp7/index.php

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19642.1	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
EC19642.2	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
EC19642.3	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**2**
EC19642.4	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**3**	**3**	**2**	**3**	**3**	**2**	**3**
EC19642.5	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Average	**2.8**	**2.6**	**2.6**	**2.6**	**2.8**	**2.4**	**2.4**	**1**	**2.8**	**3**	**2.8**	**3**	**2.6**	**2.8**	**2.8**

Subject Code	Subject Name	Category	L	T	P	C
	OPEN ELECTIVE-II	**OE**				**3**

Subject Code	Subject Name	Category	L	T	P	C
GE19621	PROBLEM SOLVING TECHNIQUES	EEC	0	0	2	1

Objectives: The student should be made

- To improve the numerical ability and problem-solving skills

S.No.	Topics
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest
8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency
12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance

Course Outcomes: On completion of the course, the students will be able to

- Understand and apply the basic principles of management.
- Understand and apply the planning, organizing and control processes.
- Will be able to understand and design organization as well as manage and develop human resource.
- Understand various theories related to the development of leadership skills, motivation techniques and team work.
- Will be able to understand and apply controlling practices in all applications.

Course Outcomes: On completion of the course, the students will be able to

- Have mental alertness
- Have numerical ability
- Solve quantitative aptitude problems with more confident
- Handling the topics: through AMCAT training

PO/PSO / CO	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
GE19621.1	1	2	2	2	1	-	-	-	1	2	1	1	2	-	1
GE19621.2	1	1	1	1	1	-	-	-	-	-	1	1	-	-	2
GE19621.3	1	1	2	1	1	-	-	-	-	-	1	1	-	-	2
GE19621.4	2	2	3	2	1	-	-	-	1	-	2	1	-	-	2
GE19621.5	2	2	3	2	1	-	-	-	-	-	2	1	-	-	2
Average	**1.4**	**1.6**	**2.2**	**1.6**	**1.0**	**-**	**-**	**-**	**1.0**	**2.0**	**1.4**	**1.0**	**2**	**-**	**1.8**

Subject Code	Subject Name (Theory Course)	Category	L	T	P	C
GE19612	PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP	EEC	0	0	6	3

Objectives:

- To empower students with overall Professional and Technical skills required to solve a real world problem.
- To mentor the students to approach a solution through various stages of Ideation, Research, Design Thinking, workflows, architecture and building a prototype in keeping with the end-user and client needs.
- To provide experiential learning to enhance the Entrepreneurship and employability skills of the students.

This course is a four months immersive program to keep up with the industry demand and to have critical thinking, team based project experience and timely delivery of modules in a project that solves world problems using emerging technologies.

To prepare the students with digital skills for the future, the Experiential Project Based Learning is introduced to give them hands-on experience using digital technologies on open-source platforms with an end-to-end journey to solve a problem. By the end of this course, the student understands the approach to solve a problem with team collaboration with mentoring from Industry and faculties. **This is an EEC category course offered as an elective, under the type, "Experiential Project Based Learning".**

Highlights of this course:

1. Students undergo training on emerging technologies
2. Students develop solutions for real-world use cases
3. Students work with mentors to learn and use industry best practices
4. Students access and use Self-Learning courses on various technologies, approaches and methodologies.
5. Collaborate in teams with other students working on the same topic
6. Have a dedicated mentor to guide

The course will involve 40-50 hours of technical training, and 40-50 hours of project development.

Course Outcomes:

On completion of the course, the students will be able to

- Upskill in emerging technologies and apply to real industry-level use cases
- Understand agile development proces
- Develop career readiness competencies, Team Skills / Leadership qualities
- Develop Time management, Project management skills and Communication Skills
- Use Critical Thinking for Innovative Problem Solving and develop entrepreneurship skills

TABLE 1: ACTIVITIES

Activity Name	Activity Description	Time (weeks)
Choosing a Project	**Selecting** a project from the list of projects categorized various technologies & business domains	2
Team Formation	Students shall form a team of 4 Members before enrolling to a project. Team members shall distribute the project activities among themselves.	1
Hands on Training	Students will be provided with hands-on training on selected technology in which they are going to develop the project.	2
Project Development	Project shall be developed in agile mode. The status of the project shall be updated to the mentors via appropriate platform	6
Code submission, Project Doc and Demo	Project deliverables must include the working code, project document and demonstration video. All the project deliverables are to be uploaded to cloud based repository such as GitHub.	3

Mentor Review and Approval	**Mentor will be reviewing the project deliverables as per the milestone schedule and the feedback will be provided to the team.**	1
Evaluation and scoring	**Evaluators will be assigned to the team to evaluate the project deliverables, and the scoring will be provided based on the evaluation metrics**	1
TOTAL		**16 WEEKS**

Essentially, it involves 15 weeks of learning and doing, and one week for evaluation. The evaluation will be carried out to assess technical and soft skills as given in Table 2.

TABLE 2: EVALUATION SCHEMA

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP			
Technical Skills		Soft Skills	
Criteria	Weightage	Criteria	Weightage
Project Design using Design Thinking	10	Teamwork	5
Innovation & Problem Solving	10	Time Management	10
Requirements Analysis using Critical Thinking	10	Attendance and Punctuality	5
Project Planning using Agile Methodologies	5	Project Documentation	5
Technology Stack (APIs, tools, Platforms)	5	Project Demonstration	5
Coding & Solutioning	15		
User Acceptance Testing	5		
Performance of Product / Application	5		
Technical Training & Assignments	5		
Total	70	Total	30
Total Weightage			100
Passing Requirement			50
Continuous Assessment Only			

The passing requirement for the courses of the type 'Experiential Project Based Learning' falling under the category of EEC is 50% of the continuous assessment marks only.

CO - PO – PSO matrices of course

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19612.1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
GE19612.2	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
GE19612.3	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
GE19612.4	3.00	3.00	3.00	3.00	3.00	3.00	1.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	3.00
GE19612.5	3.00	3.00	3.00	3.00	3.00	3.00	1.00	1.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00
Average	3.00	3.00	3.00	3.00	2.80	2.80	2.00	2.00	2.00	2.60	2.60	2.80	2.80	2.80	2.80

Subject Code	Subject Name	Category	L	T	P	C
EC19603	Problem Solving using AI and ML Techniques (Mini Project)	EEC	0	0	4	2

List of Projects

- Fuzzy logic and control systems
- Speech Signal Classification
- Image Classification and Processing
- Machine learning techniques for 5G communication networks
- Artificial Intelligence for Strategic planning in Wireless Sensor Networks
- IoT and Machine learning assisted Healthcare systems
- AI assisted vibration signal analysis to forecast seismic anomalies
- Integrating Machine learning with Embedded Real time Systems
- Machine learning for MEMS applications

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19603.1	3	3	3	3	1	3	3	3	1	2	-	2	2	3	3
EC19603.2	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
EC19603.3	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
EC19603.4	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
EC19603.5	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
Average	3	3	3	3	2.6	2.2	2.2	2.2	2.6	2.2	3	2.2	2.2	3	3

SEMESTER VII

Subject Code	Subject Name	Category	L	T	P	C
EC19701	RF AND MICROWAVE ENGINEERING	PC	3	0	0	3

Objectives: The student should be made

- To inculcate understanding of the basics required for filter and matching network of RF systems.
- To deal with the issues in the design of microwave amplifier.
- To firmly establish knowledge on the properties of various microwave passive devices.
- To deal with the microwave solid-state and vacuum tube devices.
- To obtain basic knowledge on microwave measurement techniques and RADAR engineering.

UNIT-I RF FILTER AND MATCHING NETWORK **9**

Butterworth filter – Normalized parameters, Low pass filter design, High pass filter, Bandpass filter, Bandstop filter. Tchebyscheff filter – Normalised Tchebyscheff tables, Low pass filter and High pass filter design. Impedance matching using discrete components – L Matching Network. Problem solving using Smith chart.

UNIT-II RF AMPLIFIERS **9**

Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Single-stage transistor amplifier design – Design for maximum gain (Conjugate Matching), Constant gain circles and Design for specified gain.

UNIT-III MICROWAVE NETWORK THEORY AND PASSIVE DEVICES **9**

Formulation of S-parameter, Properties of S-parameter, Theory and S-parameter formulation of passive components – E plane tee, H plane tee, Magic tee, Directional couplers, Isolator, Circulator, Terminations.

UNIT-IV MICROWAVE SOLID-STATE AND VACUUM TUBE DEVICES **9**

Active devices: PIN diode and its application as PIN switch, Varactor diode and its application as frequency multiplier, Gunn diode and its application.
Microwave Tubes: Reflex Klystron oscillator, Traveling wave tube amplifier, Cylindrical Magnetron oscillator.

UNIT-V MICROWAVE MEASUREMENTS AND RADAR SYSTEMS **9**

Microwave measurements: Power measurements – Schottky barrier diode sensor, Bolometer, Power meter, Thermocouple sensor, Calorimetric method. Insertion loss and attenuation measurements. VSWR measurements – Low VSWR and High VSWR. Impedance measurement using slotted-line method. Frequency measurements – wavemeter method, slotted line method, down-conversion method.
Radars: Introduction, Simple RADAR, Free Space RADAR range equation, Maximum Unambiguous Range, Pulsed RADAR system, Doppler Effect, CW Doppler RADAR.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Design and analyse the RF matching networks and RF filters
- Design and analyse the RF transistor amplifiers and design using conjugate match/gain circle.
- Interpret various passive microwave devices used in microwave systems.
- Interpret various solid-state and vacuum tube microwave devices.
- Measure various microwave parameters and describe the working of RADAR systems.

Text Books:

1. Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design: Theory and Applications", Pearson Education Inc., 2011, 2nd edition. (Unit 1 – Matching network, Unit 2)
2. David M. Pozar, "Microwave Engineering", Wiley India (P) Ltd, New Delhi, 2011,4th edition. (Unit 2)
3. E.Da.Silva, "High Frequency and Microwave Engineering", Butterworth Heinmann publications, Elsevier Science. 2001. (Unit 1 – Filter design)
4. Annapurna Das and Sisir K Das, "Microwave Engineering", Tata McGraw Hill Publishing Company Ltd, New Delhi, Third edition, 2015. (Unit 3, Unit 4 & Unit 5)
5. M.Kulkarni, "Microwave and RADAR Engineering", Umesh Publications, Fifth edition, 2015. (Unit 5)

Reference Books / Web links:

1 Samuel Y Liao, "Microwave Devices & Circuits", Prentice Hall of India, 2003, 3rd edition.
2 Robert E Colin, "Foundations for Microwave Engineering", John Wiley & Sons Inc, 2005.
3 Byron Edde, "Radar principles, Technology, Applications" Pearson Publications,2008.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19701.1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**
EC19701.2	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**
EC19701.3	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**3**	**2**
EC19701.4	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**
EC19701.5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**2**
Average	**3**	**2.6**	**2.6**	**2.8**	**2.8**	**2.2**	**2.2**	**2**	**1.6**	**1.8**	**1.8**	**2.4**	**2**	**3**	**2**

Subject Code	Subject Name	Category	L	T	P	C
EC19702	OPTICAL COMMUNICATION AND NETWORKS	PC	3	0	0	3

Objectives: The student should be made to:

- Acquire the knowledge of optical fiber transmission mechanisms and various fiber types.
- Study the factors which produces signal degradation in fibers
- Learn the concept of sources and power coupling in optical communication.
- Explore the trends of optical fiber measurement systems.
- Enrich the idea of optical networks.

UNIT-I INTRODUCTION TO OPTICAL FIBERS **9**

Elements of an Optical Fiber Transmission link-Basic Optical Laws and Definitions-Total internal reflection, Acceptance angle, Numerical aperture, Skew rays - Optical fiber modes and Configurations - Single mode fibers-Graded Index fiber structure -Mode theory of Circular wave guides- Overview of modes, Modes in Step-Index fibers, Linearly Polarized modes.

UNIT-II SIGNAL DEGRADATION IN OPTICAL FIBERS **9**

Attenuation - Absorption, Scattering losses, Bending losses, Core and Cladding losses. Signal distortion in Optical Wave guides- Group delay, Material dispersion, Waveguide dispersion, Signal distortion in SM fibers, Polarization mode dispersion, Intermodal dispersion - Design Optimization of SM fibers-RI profiles and cut-off wavelength.

UNIT-III FIBER OPTICAL SOURCES AND COUPLING **9**

Direct and indirect band gap materials-LED structures -Light source materials -Quantum efficiency and LED power, Modulation of a LED. Lasers diodes-modes and Threshold condition -Rate equations -External quantum efficiency -Resonant frequencies - Temperature effects. Introduction to Quantum laser and Tunable Laser. Power launching and coupling-Lensing schemes-Fiber - to- Fiber joints-Fiber splicing- Introduction to optical amplifiers.

UNIT-IV FIBER OPTIC RECEIVER AND MEASUREMENTS **9**

Principles of Photodetectors – PIN & APD - Fundamental receiver operation- Receiver configuration– Digital receiver performance - Probability of error – Quantum limit, Pre amplifiers. Fiber attenuation measurements- Dispersion measurements – Fiber refractive index profile measurements– Fiber diameter measurements – Test Equipment - OTDR.

UNIT-V OPTICAL NETWORKS AND SYSTEM TRANSMISSION **9**

Basic networks – SONET / SDH – Broadcast and select WDM networks –Wavelength routed networks – Non- linear effects on Network performance –Link power budget -Rise time budget- Operational principles of WDM and EDFA system – Solitons – Optical CDMA – Ultra high capacity networks- Introduction to Li-Fi.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Describe the various optical fiber modes and configurations
- Illustrate various signal degradation factors associated with optical fiber.
- Evaluate various optical sources and their use in the optical communication system to select the optimum transmitter.
- Analyze the optical receiver performance and measure various fiber parameters for designing optical fiber.
- Analyze the digital transmission and its associated parameters on system performance.

Text Books:

1. Gerd Keiser, “Optical Fiber Communications” McGraw -Hill International, 4th edition, 2010.
2. John.M.Senior, “Optical Fiber Communications, Principles and Practice”, Prentice Hall of India, 3rd Edition, 2008.

Reference Books / Web links:

1. Ramaswami, Sivarajan and Sasaki “Optical Networks: A Practical Perspective”, Morgan Kaufmann, 3rd Edition, 2009.
2. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.
3. Svilen Dimitrov and Harald Haas, “ Principles of LED light Communications: Towards Networked Li-Fi ”, Cambridge University Press , 2015.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19702.1	3	3	2	2	-	-	2	-	-	-	-	2	1	2	-
EC19702.2	3	3	2	2	-	-	-	-	1	-	1	2	2	2	-
EC19702.3	3	3	2	2	-	1	2	-	1	-	2	2	2	2	1
EC19702.4	3	2	2	2	-	1	2	-	2	-	2	2	2	2	1
EC197025	3	2	2	2	-	1	2	-	1	-	3	2	2	2	2
Average	3	2.6	2	2	-	1	2	-	1.2	-	2	2	1.8	2	1.3

Subject Code	Subject Name	Category	L	T	P	C
EC19703	EMBEDDED SYSTEMS	PC	3	0	0	3

Objectives: The student should be made to:

- Learn the architecture and programming of ARM processor.
- Be familiar with the embedded computing platform design and analysis.
- Be exposed to the basic concepts of real time operating system and scheduling.
- Learn the system design techniques and networks for embedded systems
- Be familiar with different applications of embedded system

UNIT-I **INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS** **9**

Complex systems and microprocessors– Embedded system design process –Design example: GPS Moving map - Model train controller- Instruction sets preliminaries - ARM processor –- supervisor mode, exceptions and traps – Co-processors- Memory system mechanisms – CPU: programming input and output - CPU performance- CPU power consumption.

UNIT-II **EMBEDDED COMPUTING PLATFORM DESIGN** **9**

AMBA bus - Designing with computing platforms – platform-level performance analysis - Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT-III **PROCESSES AND OPERATING SYSTEMS** **9**

Introduction – Multiple tasks and multiple processes – Multi rate systems- Pre emptive real-time operating systems- Priority based scheduling- Inter process communication mechanisms – Evaluating operating system performance- Example Real Time Operating Systems-POSIX-Windows CE.

UNIT-IV **SYSTEM DESIGN TECHNIQUES AND NETWORKS** **9**

Design methodologies- Design flows - Requirement analysis – Specifications-System analysis and architecture design – Quality assurance techniques- Distributed embedded systems: CAN bus, I2C – MPSoCs and shared memory multiprocessors

UNIT-V **CASE STUDY** **9**

Data compressor - Alarm clock - Audio player - Software modem-Digital still camera - Telephone answering machine- Engine control unit – Video accelerator.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Describe the architecture and programming of ARM processor.
- Outline the concepts of embedded systems computing platforms
- Explain the basic concepts of real time operating system and can able to differentiate the general purpose operating system from the real time operating system
- Use the system design techniques to develop embedded systems
- Model real-time applications using embedded-system concepts

Text Books:

1 Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.

Reference Books / Web links:

1 Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", 3rd Ed Cengage Learning, 2012.

2 David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional,2007

3 Raymond J.A. Buhr, Donald L.Bailey, "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall, 1999.

4 C.M. Krishna, Kang G. Shin, "Real-Time Systems", International Editions, Mc Graw Hill 1997

5 K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2005.

6 Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill, 2004.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19703.1	3	3	2	3	3	3	3	3	2	3	3	3	3	3	3
EC19703.2	3	2	2	2	1	2	2	2	2	3	2	3	3	2	2
EC19703.3	3	1	2	2	3	1	2	1	2	3	2	3	2	2	2
EC19703.4	3	2	2	3	1	2	2	2	2	3	2	3	2	1	2
EC19703.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	2.2	2.2	2.6	2.2	2.2	2.4	2.2	2.2	3	2.4	3	2.6	2.8	2.4

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-III	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-IV	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
EC19711	**EMBEDDED LABORATORY**	**PC**	**0**	**0**	**4**	**2**

Objectives: The student should be made to:

- Learn the working of ARM processor
- Understand the Building Blocks of Embedded Systems
- Analyse the concept of memory map and memory interface
- develop programs to interface I/O s and FPGA with ARM processor
- Study the interrupt performance

List of Experiments

1	Study of ARM evaluation system
2	Interfacing of LED and Flashing of LEDS
3	Interfacing of Switches
4	Interfacing of stepper motor
5	Interfacing of ADC and DAC
6	Interfacing of serial port.
7	Interfacing of keyboard and LCD.
8	Interfacing of EPROM and interrupt
9	Interfacing of PWM
10	Interfacing of temperature sensor
11	Interrupt the performance characteristics of ARM and FPGA.

Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- Interface memory and write programs related to memory operations
- Interface A/D and D/A converters with ARM processor
- Analyse the performance of interrupt
- Write programs for interfacing Keyboard, LCD display, Stepper motor and sensor
- Formulate a mini project using embedded system

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19711.1	2	2	3	2	3	2	2	2	2	2	2	2	2	2	3
EC19711.2	2	2	2	2	1	1	1	2	2	2	2	1	1	3	1
EC19711.3	2	3	2	2	3	1	2	2	2	2	2	2	1	3	2
EC19711.4	2	2	3	2	3	3	3	3	3	2	2	2	3	3	2
EC19711.5	2	2	3	2	3	3	3	3	3	3	3	3	3	2	3
Average	2	2.2	2.6	2	2.6	2	2.2	2.4	2.4	2.2	2.2	2	2	2.6	2.2

Subject Code	Subject Name	Category	L	T	P	C
EC19712	ADVANCED COMMUNICATION SYSTEMS LABORATORY	PC	0	0	4	2

Objectives: The student should be made to:

- Understand the transmission and reception of signals in the fiber optic link
- Study the characteristics of fiber.
- Understand the practical aspects of microwave source and the radiation characteristics of horn antenna.
- Realize the S-parameters of microwave components.
- Give exposure on different wireless communication schemes

List of Experiments

OPTICAL COMMUNICATION LABORATORY:	
1	DC Characteristics of LED and PHOTODIODE
2	Measurement of losses in a given optical fiber (propagation loss, bending loss) and numerical aperture
3	Analog and Digital communication link using optical fiber.
4	Study of optical Fiber mode Characteristics
RF AND MICROWAVE LABORATORY:	
5	Reflex Klystron – Mode characteristics
6	Gunn Diode - VI Characteristics
7	Measurement of frequency, guide wavelength and VSWR in a microwave test bench
8	Measurement of Radiation pattern, gain and Impedance of horn antenna
9	Directional Coupler Characteristics.
10	S-parameter Measurement of Isolator and Circulator
11	S-parameter Measurement of Magic Tee.
WIRELESS COMMUNICATION LABORATORY:	
12	OFDM signal transmission and reception using software defined radio.
13	Spectrum sensing using software defined radio.
14	Simulation of MIMO communication.

Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- Analyze the performance of optical transmitter and receiver
- Examine the mode characteristics of fiber
- Evaluate the radiation pattern of horn antenna and the characteristics of microwave sources.
- Compute the S-parameter of microwave components.
- Analyze the performance of wireless communication scheme.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
EC19712.1	3	2	2	2	1	2	2	2	2	3	2	2	3	3	2
EC19712.2	3	2	2	2	1	2	2	2	2	3	2	2	3	3	2
EC19712.3	3	2	2	2	1	2	2	2	2	3	2	2	3	3	2
EC19712.4	3	2	2	2	1	2	2	2	2	3	2	2	3	3	2
EC19712.5	3	2	2	2	3	2	2	2	2	3	2	2	3	3	2
Average	3	2	2	2	1.4	2	2	2	2	3	2	2	3	3	2

SEMESTER-VIII

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-V	**PE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
	PROFESSIONAL ELECTIVE-VI	**PE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EC19811	**PROJECT WORK**	**EEC**	0	0	20	10

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE I

Subject Code	Subject Name	Category	L	T	P	C
CS19301	COMPUTER ARCHITECTURE	PE	3	0	0	3

Objectives: The student should be made

- To learn the basic structure and operation of digital computer.
- To familiarize the students with arithmetic and logic unit and implementation of fixed point and floating-point arithmetic operations.
- To make the students quantitatively evaluate simple computer designs and their sub-modules.
- To make the students to understand about the Pipelining and Hazards.
- To expose and make the students to learn about the memory system design and different ways of communicating with I/O devices and standard I/O interfaces.

UNIT I	**INTRODUCTION& INSTRUCTIONS**	**9**

Introduction –RISC – CISC, Eight ideas – Components of a computer system – Technology – Performance – Power wall – Instructions – Operations & Operands, Representing instructions, Logical operations – Instructions for decision making- Addressing Modes. Case Study: Evolution of Intel x86 architecture.

UNIT II	**ARITHMETIC UNIT**	**9**

Design of ALU, Integer Arithmetic: Addition, Subtraction, Multiplication and Division – Floating Point Arithmetic: Representation, Addition, subtraction, Multiplication.

UNIT III	**PROCESSOR AND CONTROL UNIT**	**9**

MIPS implementation – Building data path – Pipelining – Pipelined data path and control – Handling Data hazards & Control hazards – Exceptions.

UNIT IV	**PARALLELISM**	**9**

Instruction-level-parallelism – Parallel processing challenges – Flynn's classification – Hardware multithreading – Multicore processors- Case Study: Key Elements of ARM 11 MPCORE

UNIT V	**MEMORY AND I/O SYSTEMS**	**9**

Memory hierarchy - Memory technologies – Cache basics – Measuring and improving cache performance - Virtual memory – TLBs, Input/output system, programmed I/O, DMA and interrupts, I/O processors. Case Study: RAID

Total Contact Hours	**45**

Course Outcomes: On completion of course students will be able to

- Understand the impact of instruction set architecture on cost-performance of computer design.
- Ability to perform computer arithmetic operations
- Design and anlayze pipelined control units and hazards.
- Develop the system skills in parallelism and multithreading.
- Evaluate the performance of memory systems.

TEXT BOOK:

1. David A. Patterson and John L. Hennessey, "Computer organization and design', Morgan Kauffman / Elsevier, Fifth edition, 2014.

References:

1. V.CarlHamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", VI th edition, Mc Graw-Hill Inc, 2012.
2. William Stallings "Computer Organization and Architecture Designing for performance", PHI Pvt. Ltd., Eastern Economy Edition, Ninth Edition, 2013.
3. . Vincent P. Heuring, Harry F. Jordan, "Computer System Architecture", Second Edition, Pearson Education, 2005.
4. Govindarajalu, "Computer Architecture and Organization, Design Principles and Applications", first edition, Tata McGraw Hill, New Delhi, 2005.
5. John P Hayes, "Computer Architecture and Organization", McGraw Hill,Third Edition, 2002.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CS19301.1	**2**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**
CS19301.2	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**1**	**1**	**2**
CS19301.3	**2**	**2**	**3**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**1**
CS19301.4	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**1**	**2**	**2**	**2**
CS19301.5	**2**	**2**	**3**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**2**
Average	**2.2**	**2.2**	**2**	**1.2**	**2**	**1.6**	**1.75**	**-**	**2**	**-**	**1.75**	**1**	**1.8**	**2**	**1.8**

Subject Code	Subject Name	Category	L	T	P	C
EC19P51	INTRODUCTION TO AVIONICS	PE	3	0	0	3

Objectives: The student should be made to

- To introduce the relevance of Avionics in aircraft and space craft systems along with an insight into the basics of microprocessors.
- To create awareness about the evolution of avionics system architecture and the standard data buses associated with it.
- To expose students to control and display technologies used in flight decks and cockpits.
- To introduce the concepts of various navigation techniques.
- To expose students to software assessment and validation and the importance of using autopilot system

UNIT-I	INTRODUCTION TO AVIONICS	9

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to Microprocessor and memories.

UNIT-II	DIGITAL AVIONICS ARCHITECTURE	8

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629

UNIT-III	FLIGHT DECKS AND COCKPITS	9

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS

UNIT-IV	INTRODUCTION TO NAVIGATION SYSTEMS	10

Radio navigation – VOR/DME, Hyperbolic navigation-LORAN and OMEGA, Landing system-ILS, MLS, Inertial Navigation Systems (INS)- INS block diagram – Satellite navigation systems – GPS.

UNIT-V	SOFTWARE ASSESSMENT AND AUTO PILOT	9

Fault tolerant systems- Software Assessment and Validation -Civil and Military standards- Certification of Civil Avionics. Auto pilot– Basic principles, Longitudinal and lateral auto pilot.

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Understand the relevance of Avionics in aircraft and space craft systems along with an insight into the basics of microprocessors.
- Aware of the evolution of avionics system architecture and the standard data buses associated with it.
- Learn about the evolving control and display technologies used in flight decks and cockpits.
- Understand the various operations of monitoring and controlling the movement of a craft from one place to another through the various navigation techniques.
- Expose to software assessment and validation and the importance of using autopilot system.

Text Book (s):

1. Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.
2. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993

Reference Books(s) / Web links:

1. Albert Helfrick., "Principles of Avionics", Avionics Communications Inc., 2004
2. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
3. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000
4. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific 5. Jim Curren, “Trend in Advanced Avionics”, IOWA State University, 1992

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P51.1	-	2	-	2	-	-	2	2	1	2	2	2	2	2	1
EC19P51.2	2	2	2	2	2	-	2	2	2	2	2	2	1	1	-
EC19P513	2	3	2	2	2	-	2	2	2	2	2	2	1	2	-
EC19P51.4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1
EC19P51.5	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1
Average	2.5	2.6	2.2	2.2	2	2	2	2	1.8	2	2	2	1.6	1.8	1

Subject Code	Subject Name	Category	L	T	P	C
EC19P52	INFORMATION THEORY AND CODING	PE	3	0	0	3

Objectives: The student should be made

- To know the basic principles of information theory and text coding.
- To study the various voice coding techniques.
- To learn the concepts of image coding.
- To understand the principles of video coding techniques.
- To acquire knowledge on error control coding techniques.

UNIT-I	**INFORMATION THEORY AND TEXT CODING**	**9**

Information – Entropy, Information rate, Kraft McMillan inequality, Huffman coding, Extended Huffman coding –Adaptive Huffman Coding and LZW algorithm.

UNIT-II	**VOICE CODING**	9

Adaptive Differential Pulse Code Modulation, Adaptive delta modulation, Adaptive sub band coding, Adaptive transform coding, Linear predictive vocoder and comparison of various voice coding techniques.

UNIT-III	**IMAGE CODING**	**9**

Image compression and its need, Shift codes, Arithmetic Coding, Run length coding, Transform coding and JPEG standard.

UNIT-IV	**VIDEO CODING**	**9**

Video Compression: Principles-I, B, P frames, Motion estimation, Motion compensation, Introduction toH.261, MPEG Video compression standard.

UNIT-V	**ERROR CONTROL CODING**	**9**

Convolutional codes, Cyclic codes, Cyclic Redundancy Check codes, Reed Solomon codes, BCH Codes, Repetition codes and principle of Turbo coding.

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- Recall various coding techniques for text compression.
- Classify the different voice coding techniques.
- Apply the various coding techniques for image compression.
- Describe the video coding techniques.
- Evaluate the various error control coding techniques.

Text Books:

1. Simon Haykin, “Digital Communications”, John Wiley and Sons, 2010.
2. K Sayood, “Introduction to Data Compression” 3/e, Elsevier 2006

Reference Books / Web links:

1. R Bose, “Information Theory, Coding and Cryptography”, TMH 2007
2. S Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007
3. Amitabha Bhattacharya, “Digital Communication”, TMH 2006
4. Mark Nelson, “Data Compression Book”, BPB Publication 1992.
5. Watkinson J, “Compression in Video and Audio”, Focal Press, London, 1995.
6. Rafael C. Gonzalez, Richard E. Woods, ‘Digital Image Processing', Pearson, Second Edition, 2004.
7. Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Perason Education Asia, 2002

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO 11	PO 12	PS O1	PS O2	PS O3
EC19P52.1	**3**	**3**	**1**	**3**	**2**	**2**	**2**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
EC19P52.2	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**-**	**2**	**1**	**2**	**2**	**3**	**3**	**2**
EC19P52.3	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**
EC19P52.4	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**
EC19P52.5	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**-**	**2**	**-**	**1**	**2**	**3**	**2**	**2**
Average	**3**	**2.2**	**1.6**	**2.4**	**1.2**	**1.8**	**1.6**	**1**	**2**	**1**	**1.4**	**2**	**2.6**	**2.6**	**2.2**

Subject Code	Subject Name	Category	L	T	P	C
EC19P53	INTRODUCTION TO MEMS	PE	3	0	0	3

Objectives: The student should be made

- To introduce the fundamental concepts of MEMS & Microsystem.
- To gain a fundamental understanding of standard microfabrication techniques.
- To understanding the fundamental principles behind the operation of MEMS devices/systems
- To apply knowledge of microfabrication techniques and applications to the design and manufacturing of an MEMS device or a Microsystem
- To educate on the packaging of MEMS to disciplines beyond Electrical and Mechanical engineering

UNIT-I **MEMS OVERVIEW** **9**

MEMS and Microsystems, evolution of micro fabrication, MEMS Roadmaps, Benefits of Miniaturization Microsystem and microelectronics, Silicon, glass, metals, dielectrics, and carbides. Silicon dioxide, silicon carbide, silicon nitride, and polycrystalline silicon, application of Microsystems. Micro electro mechanical systems (MEMS) devices and technologies. Visit to Centre of Excellence in MEMS & Microfluidics (CEMM)

UNIT-II **MICROMACHINING** **9**

Bulk micromachining – overview of etching, isotropic and anisotropic etching, wet etchants, etch stop, dry etching, comparison of wet and dry etching, Surface micromachining– General description, process, mechanical problems associated with surface micromachining, LIGA- General description, process, material for substrate and photoresists, Electroplating.

UNIT-III **MEMS MATERIAL AND PROCESSES** **9**

Structure of silicon and other materials, Polymer for MEMS, Silicon wafer processing, Thin-film deposition- Physical vapor Deposition, Chemical vapor deposition, Lithography, Positive Resist, Negative photo Resist, Wet Etching and Dry Etching**.**

UNIT-IV **MICRO SENSOR AND ACTUATORS** **9**

Working principles of MEMS Sensors -Acoustic wave sensors, Bio sensors, Chemical sensor, optical sensors, Micro accelerometer, Capacitive and Piezoresistive Pressure sensors and Thermal Sensors, Micro actuation – thermal forces, Shape Memory alloys, Piezo electric Crystal and electrostatic forces Case study: Biosensors & Chemical Sensors

UNIT-V **MEMS APPLICATIONS AND PACKAGING** 9

Gyroscope, Accelerometer, Chemical Sensor, Metal Oxides Based Sensor, SAW Sensor, VOC sensor, Overview of packaging, packaging design, selection of packaging materials, levels of Microsystem packaging, interface in Microsystem packaging, essential packaging technologies, Assembly of micro systems.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Understand the MEMS and micro devices, micro systems and their needs.
- Acquire knowledge on recent developments and the science and technology behind micro- and nano-systems.
- Gain technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices.
- Gain knowledge of basic approaches for designing various sensors
- Appreciate the potential applications of micro- and nano-systems

Text Books:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata-McGraw Hill, New Delhi, 2007.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication,1st ed. 2000. Corr. 2nd printing 2004 Edition

Reference Books / Web links:

1. Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 2002, eBook Published 8th Oct 2018. DOIhttps://doi.org/10.1201/9781482274004.
2. Chang Liu, Foundations of MEMS, Pearson Education India, 2012.
3. NadimMaluf, KirtWillams, An Introduction to Microelectromechanical Systems Engineering Artech House Publishers, London, Second Edition, 2004.
4. K.J.Vinoy,Vijay.K.Varadan, "RF MEMS and their Applications" John Wiley & Sons Reprint@2003.
5. Stephen Beeby, Graham Ensell, Michael Kraft, Neil White, " MEMS Mechanical Sensors", 2004, Artech House, Inc.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19P53.1	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
EC19P53.2	**2**	**2**	**1**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
EC19 P53.3	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**3**
EC19 P53.4	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**
EC19 P53.5	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**3**	**2**
Average	**2**	**1.8**	**2.4**	**2**	**2**	**2.4**	**2**	**2.6**	**2**	**2.8**	**1.6**	**2**	**2.2**	**2.2**	**2.2**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19P54	**NANO ELECTRONICS**	**PE**	**3**	**0**	**0**	**3**

Objectives: The student should be made

- To understand the basics of nanoscience and nanotechnology.
- To understand the design and working of various nanodevices.
- To study various fabrication methods for modelling nanodevices.
- To understand and evaluate SET- based nanodevices.
- To apply SPICE simulations on nanoelectronics circuits and analyse its issues.

UNIT-I	**NANOSCIENCE**	**9**

Introduction to Nanoscience, Basics of Quantum Mechanics - Schrodinger equation, Density of States, Particle in a box Concepts, double-slit theory, Introduction to Nanotechnology - meso structures - advantages and various issues.

UNIT-II	**NANOELECTRONIC DEVICES**	**9**

Introduction to Nanoelectronic Devices: Carbon nanotube, FINFET, Quantum transport devices – Super conducting Digital Electronics, Quantum computing using super conductors.

UNIT-III	**NANO FABRICATION TECHNIQUES**	**9**

Microelectronics & Nanoelectronics fabrication processes - Clean room standards, Semiconductor wafer cleaning, photolithography, ion implantation, diffusion and Oxidation. Thin film Depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching Techniques: Dry and wet etching, electromechanical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect Ratio (LIGA and LIGA-like) technology.

UNIT-IV	**SINGLE ELECTRON TECHNOLOGY**	**9**

Single electron transistor – Principle of operation- analytic I –V model, SET logic gates, Programmable SET, SET Full Adder, threshold logic.

UNIT-V	**CASE STUDY**	**9**

Simulating single electron devices & circuits- Binary, Multiple valued and mixed mode logics- SET spice modelling- Quantum computers.

	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to

- Understand the basic nanoscience and various aspects of nanotechnology for exploring application specific nanodevices.
- Analyse the design and efficacy of various nanoelectronic devices.
- Apply various micro &nanofabrication methods for modelling nano devices.
- Model SET- based nanodevices and evaluate its working using I-V characteristic studies.
- Apply SPICE simulations on nanoelectronic circuits and analyse its issues.

Text Books:

1. K.E. Drexler, Nanosystems: molecular machinery, manufacturing, and computation, John Wiley & Sons, Inc. New York, NY, USA ©1992 ISBN:0-471-57518-6
2. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2017.
3. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, John Wiley & Sons, 2003.
4. George W. Hanson, of university of WosconsinMilwaukeen, Fundamentals of Nanoelectronics, Book was published in 2008, by the editorial Pearson Prentice Hall
5. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge, U.K, New York, NY, USA : Cambridge University Press, 1998.

Reference Books / Web links:	
1	Wasshuber. C, SIMON - Simulation of Nano Structures: Computational Single- Electronics, Springer-Verlag, 2001.
2	Rainer waser, Nanoelectronics and information technology advanced electronic materials and novel devices, 3rd Enlarge edition, Willy-VCH, Germany, 2012.
3	Mark A.Reed and Takhee Lee, Molecular Nanoelectronics, American Scientific Publishers (2003).
4	Takahashi.Y, A comparative study of single-electron memories, IEEE Trans. Electron Devices, 1998, pp. 2365–2371. (JOURNAL PAPER)
5	Ken Uchida,Junj Koga, Ryuji Ohba& Akira Toriumi, Programmable SET logic for future low power intelligent LSI, IEEE transaction on electron devices, July 2003,pp.1623, (JOURNAL PAPER)

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19P54.1	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
EC19P54.2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
EC19 P54.3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
EC19 P54.4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
EC19 P54.5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
Average	**3**	**2.8**	**2.6**	**2.8**	**2.4**	**2.4**	**2.2**	**1.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.6**	**2.8**	**3**

Subject Code	Subject Name	Category	L	T	P	C
CR19P61	MICRO FABRICATION LABORATORY	PE	0	0	2	1

Objectives:

- To familiarize the concept of micro electro mechanical systems
- To gain clear understating of the micro fabrication techniques
- To strengthen the fundamentals of fabricating MEMS devices
- To impart knowledge on the CAD design of micro devices
- To empower students to design and fabricate novel micro devices

1	Micro Electro Mechanical Systems (MEMS)- Introduction, definitions and applications
2	Materials for micro-fabrication
3	Micro fabrication processes: substrate cleaning, doping, oxidation, deposition, photolithography, etching
4	Laboratory session 1- wafer cleaning process
5	Laboratory session 2- oxidation
6	Laboratory session 3- thin film deposition
7	Laboratory session 4- photolithography
8	Laboratory session 5- etching
9	Laboratory session 6- characterization of micro devices
10	CAD design of micro-devices, Simulation of Micro Devices
11	Recent developments in micro fabrication
	Total contact hours : 30

Course Outcomes:

On completion of the course, students will be able to

- understand the fundamentals of micro fabrication.
- demonstrate the various fabrication techniques.
- analyse the working and design of MEMS devices.
- design complex micro devices in various CAD software.
- fabricate any sensor in real time

References:

1. Chang Liu, “Foundations of MEMS”, Pearson Education Inc., 2012
2. Tai Ran Hsu, “MEMS and Micro Systems Design and Manufacture”, Tata McGraw Hill, New Delhi, 2002.
3. Dr. Hardik J. Pandya,”Sensors and Actuators”, NPTEL video course. https://www.youtube.com/playlist?list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CR19P61.1	3	2	1	2	2	3	2	1	2	2	2	2	2	2	3
CR19P61.2	3	3	3	3	2	2	2	2	2	3	2	3	3	3	3
CR19P61.3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	3
CR19P61.4	3	3	3	3	2	2	2	2	2	2	2	3	3	3	3
CR19P61.5	3	3	3	3	3	2	2	1	3	3	3	3	2	3	3
Average	3	2.8	2.6	2.8	2.4	2.4	2.2	1.6	2.4	2.4	2.4	2.8	2.6	2.8	3

PROFESSIONAL ELECTIVE II

Subject Code	Subject Name	Category	L	T	P	C
EC19P55	SPEECH AND AUDIO PROCESSING	PE	3	0	0	3

Objectives: The student should be made

- To understand Speech production system and describe the fundamentals of speech
- To apply different speech analysis techniques
- To understand and evaluate statistical speech models
- To analyze and apply Text to Speech Synthesis models for real world applications
- To evaluate lossy and lossless audio coders

UNIT-I	MECHANICS OF SPEECH AND AUDIO	9

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production- Filter-Bank and LPC Methods -Psychoacoustics – Sound pressure level and loudness – Frequency analysis and critical bands-source-filter model of speech production

UNIT-II	SPEECH ANALYSIS	9

Features, 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.

UNIT-III	SPEECH MODELING AND RECOGNITION	9

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, HMM Training and Testing-Large Vocabulary Continuous Speech Recognition: Architecture of large vocabulary continuous speech recognition system – acoustics and language models – n-grams, Applications.

UNIT-IV	SPEECH SYNTHESIS	9

Text-to-Speech Synthesis: Concatenative and Waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications

UNIT-V	DIGITAL AUDIO SIGNAL PROCESSING	9

Lossless Audio Coding – Lossy Audio Coding - ISO-MPEG-1, 2, 2-Advaned, 4A Audio Coding - Digital Audio Restoration-Modelling of audio signals- Correlated Noise Pulse Removal- Pitch variation defects

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Understand speech production system and acoustic- phonetics concept of speech
- Apply DSP concepts to process digitized speech data and to extract features
- Evaluate statistical models for Speech recognition applications
- Analyse Text-to-Speech synthesis methods
- Evaluate Audio coding algorithms

Text Books:

1. Lawrence Rabiner and Biing-Hwang Juang,B.Yegnanarayana “Fundamentals of Speech Recognition”, Pearson Education, 2008.
2. Lawrence Rabiner and Ronald W.Schaffer, “Digital Processing of Speech signals”, Prentice Hall, 1978

Reference Books:

1. Ben Gold, Nelson Morgan, and Dan Ellis, Speech and Audio signal processing: processing and perception of speech and music, John Wiley & Sons, 2011.
2. UdoZölzer, A John , “Digital Audio Signal Processing”, Second Edition, Wiley& sons Ltd, 2008.
3. John G. Beerends, Mark Kahrs, Karlheinz Brandenburg, “Applications of Digital Signal Processing to Audio And Acoustics”, Kluwer Academic Publishers, 2002.
4. Xuedong Huang, Alex Acero, Hsiao, Wuen Hon, “Spoken Language Processing”, Prentice Hall 2001.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19P55.1	**3**	**1**	**-**	**3**	**2**	**1**	**3**	**2**	**1**	**2**	**-**	**1**	**3**	**2**	**2**
EC19P55.2	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**2**
EC19P55.3	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**2**
EC19P55.4	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**3**
EC19P55.5	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**1**	**3**	**3**	**2**
Average	**3**	**2.6**	**1.8**	**2.6**	**2.8**	**2.4**	**2.2**	**2**	**1.4**	**2.2**	**0**	**1**	**3**	**2.8**	**2.2**

Subject Code	Subject Name	Category	L	T	P	C
EC19P56	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	PE	3	0	0	3

Objectives: The student should be made

- To understand the basics of EMI.
- To acquire knowledge on EMI coupling principles.
- To learn various EMI control techniques.
- To acquaint with solution methods for EMC PCB.
- To become familiar with various EMI measurement techniques.

UNIT-I	EMI/EMC CONCEPTS	9

EMI-EMC definitions, Sources and victim of EMI- Conducted and Radiated EMI Emission and Susceptibility- Transient EMI, ESD- Radiation Hazards.

UNIT-II	EMI COUPLING PRINCIPLES	9

Conducted, radiated and transient coupling- Common ground impedance coupling- Common mode and ground loop coupling- Differential mode coupling- Near field cable to cable coupling, cross talk- Field to cable coupling- Power mains and Power supply coupling.

UNIT-III	EMI CONTROL TECHNIQUES	9

Shielding- Shielding Material-Shielding integrity at discontinuties, Filtering- Characteristics of Filters-Impedance and Lumped element filters-Telephone line filter, Power line filter design, Filter installation and Evaluation, Grounding- Measurement of Ground resistance-system grounding for EMI/EMC-Cable shielded grounding, Bonding, Isolation transformer, Transient suppressors, EMI gaskets.

UNIT-IV	EMC DESIGN OF PCB	9

Component selection and mounting; PCB trace impedance- Routing- Cross talk control, Power distribution decoupling- Zoning- Grounding- VIAs connection- Terminations.

UNIT-V	EMI MEASUREMENTS AND STANDARDS	9

Open area test site- TEM cell- EMI test shielded chamber and shielded ferrite lined anechoic chamber- EMI Rx and spectrum analyzer- Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462. Frequency assignment - spectrum conversation.

Total Contact Hours	:	45

Course Outcomes: On completion of course, students will be able to

- Identify the various types and mechanisms of EMI
- Analyze the EMI with various ways of coupling
- Control EMI using various techniques
- Construct printed circuit boards with minimum interference
- Demonstrate their acquired knowledge in EMI measurements and various standards

Text Books:

1. W. Prasad Kodali, V.P.Kodali, “Engineering EMC Principles, Measurements, Technologies and Computer Models”, Second edition, Wiley, 2001.
2. Clayton R.Paul, “Introduction to Electromagnetic Compatibility”, Second edition, John Wiley Publications, 2006.

Reference Books / Web links:

1. Henry W.Ott., “Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, New York, 1988.
2. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, Third edition, Artech house, Norwood, 1986.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PS O1	PS O2	PS O3
EC19P56.1	3	3	3	2	1	1	1	1	2	2	3	3	2	3	2
EC19P56.2	3	3	3	2	1	1	1	1	2	2	3	3	2	3	2
EC19P56.3	3	3	3	2	1	1	1	1	2	2	3	3	2	3	2
EC19P56.4	3	3	3	2	1	1	1	1	2	2	3	3	3	3	2

EC19P56.5	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**2**	**3**	**2**
Average	**3**	**3**	**2.8**	**2.2**	**1.2**	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**2.2**	**3**	**2**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19P57	**BIOMEDICAL ELECTRONICS**	**PE**	**3**	**0**	**0**	**3**

Objectives: The student should be made

- To gain knowledge about the various physiological parameters both electrical and non-electrical methods of recording.
- To acquire knowledge on Bio-chemical and non-electrical parameter measurement.
- To study about the various assist devices used in the hospitals.
- To gain knowledge about equipment used for physical medicine.
- To be familiar with the various recently developed diagnostic and therapeutic techniques.

UNIT-I	**ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING**	**9**

The origin of Bio-potentials; bio potential electrodes, biological amplifiers, ECG, EEG, EMG, EOG, PCG, lead systems and recording methods, typical waveforms and signal characteristics

UNIT-II	**BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT**	**9**

pH, PO2, PCO2, colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory, Blood pressure, temperature, pulse measurement, Blood Cell Counters

UNIT-III	**ASSIST DEVICES**	**9**

Cardiac pacemakers, DC Defibrillator, Dialyser, Heart lung machine, Tele-stimulators

UNIT-IV	**PHYSICAL MEDICINE AND BIOTELEMETRY**	**9**

Diathermies-techniques and waveforms, Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Telemetry principles, frequency selection, biotelemetry, Radio-pill, electrical safety

UNIT-V	**IMAGING MODALITIES AND RECENT TRENDS IN MEDICAL INSTRUMENTATION**	**9**

Introduction to X-ray, CT, MRI, Ultrasound and PET, Thermograph, Endoscopy unit, Lasers in medicine, Cryogenic application, Introduction to telemedicine

	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- Identify the application of electronics in medical diagnosis.
- Interpret biochemical and various physiological information
- Describe the working of units which will help to restore normal functioning.
- Develop knowledge about equipment used for microsurgery using non-invasive technique
- Utilize the recent trends in the field of medicine

Text Books:

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2011.
2. John G.Webster, “Medical Instrumentation Application and Design”, 3rd Edition, Wiley India Edition, 2009.

Reference Books / Web links:

1. Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TATA McGraw-Hill, New Delhi, 2015.
2. Joseph J.Carr and John M.Brown, “Introduction to Biomedical Equipment Technology”, John Wiley and Sons, New York, Fourth Edition, 2008
3. L. A. Geddes, L. E. Baker., “Principles of Applied Biomedical Instrumentation”, 3rd Edition, John Wiley & Sons Inc., 2008.
4. http://www.daenotes.com/electronics/industrial-electronics/x-rays-machine-block-diagram-working

PO/PSO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO1 2**	**PS O1**	**PS O2**	**PSO 3**
EC19P57.1	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
EC19P57.2	**3**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**1**	**2**
EC19P57.3	**3**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**2**
EC19P57.4	**3**	**1**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
EC19P57.5	**3**	**1**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**
Average	**3**	**1.8**	**1.6**	**2.2**	**2.2**	**2.4**	**2**	**1.8**	**2.2**	**2.6**	**2.2**	**2**	**1.8**	**2.2**	**2.6**

Subject Code	Subject Name	Category	L	T	P	C
GE19304	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	PE	3	0	0	3

Objectives: The student should be made

- To expose the students to the basic concepts of management in order to aid in understanding how an organization functions, and in understanding the complexity and wide variety of issues managers face in today's business firms.

UNIT-I	INTRODUCTION TO MANAGEMENT	9

Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of management thought. Organization: Types and environmental factors.

UNIT-II	PLANNING AND DECISION MAKING	9

General Framework for Planning – Planning Process, Types of Plans, Management by Objectives; Decision making and Problem Solving - Steps in Problem Solving and Decision Making.

UNIT-III	ORGANIZATION AND HRM	9

Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization. Human Resource Management & Business Strategy: Talent Management and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.

UNIT-IV	LEADING AND MOTIVATION	9

Leadership, Power and Authority, Leadership Styles, Leadership Skills, Leader as Mentor and Coach, Team Leadership. Motivation – Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories – Needs Hierarchy Theory, Two Factor Theory, Theory X and Y.

UNIT-V	CONTROLLING	9

Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems. Managing productivity- Cost control- Purchase control- Maintenance control- Quality control- Planning operations. Managing globally- Strategies for International business.

Total Contact Hours	:	45

Course Outcomes: On completion of the course, the students will be able to

- Understand and apply the basic principles of management.
- Understand and apply the planning, organizing and control processes.
- Will be able to understand and design organization as well as manage and develop human resource.
- Understand various theories related to the development of leadership skills, motivation techniques and team work.
- Will be able to understand and apply controlling practices in all applications.

Text Book (s):

1. Principles of Management, Prakash Chandra Tripathi, Tata McGraw-Hill Education, 2008.
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

Reference Books(s) / Web links:

1. Essentials of Management, Koontz Kleihrich, Tata Mc – Graw Hill.
2. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO1	PSO2	PSO3
GE19304.1	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-
GE19304.2	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-
GE19304.3	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-
GE19304.4	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-
GE19304.5	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-
Average	-	-	-	-	-	1	-	1	3	2	1	2	-	-	-

Subject Code	Subject Name	Category	L	T	P	C
GE19401	FUNDAMENTALS OF MECHANICS	PE	3	0	0	3

Objectives: The student should be made

- To understand the basics of mechanics and apply the concept of equilibrium to solve problems of concurrent forces
- To understand the concept of equilibrium and to solve problems of rigid bodies
- To learn about the center of gravity and moment of inertia of surfaces and solids
- To learn the concepts of dynamics of particles
- To learn the basic concepts of friction

UNIT-I STATICS OF PARTICLES **9**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT-II EQUILIBRIUM OF RIGID BODIES **8**

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – (Descriptive treatment only)

UNIT-III PROPERTIES OF SURFACES AND SOLIDS **12**

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem

UNIT-IV DYNAMICS OF PARTICLES **8**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT-V FRICTION **8**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction, Ladder friction and rolling resistance.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Understand the analysis of force in the system
- Solve problems in engineering systems using the concept of static equilibrium
- Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia of composite areas
- Solve problems involving kinematics and kinetics of rigid bodies in plane motion
- Solve problems involving frictional phenomena in machines

Text Books:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books / Web links:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
3. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4thEdition, Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
5. Vela Murali, "Engineering Mechanics", Oxford University Press (2010).

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
GE19401.1	3	3	2	2	-	1	-	-	-	-	2	2	-	-	2
GE19401.2	3	3	2	2		1	-	-	-	-	2	2	-	-	2
GE19401.3	3	3	2	2		1	-	-	-	-	2	2	-	-	2
GE19401.4	3	3	2	2		1	-	-	-	-	2	2	-	-	2
GE19401.5	3	3	2	2			-	-	-	-	2	2	-	-	2
Average	**3**	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**

Subject Code	Subject Name	Category	L	T	P	C
CR19P62	MICROFLUIDICS LABORATORY	PE	0	0	2	1

Objectives: The student should be made

- To introduce and strengthen the concept of microfluidic technology
- To gain clear understanding of fabrication techniques in microfluidics
- To familiarize the ways to analyse various applications of microfluidics
- To impart knowledge on the CAD design of micro-mixers
- To empower the students to design and fabricate novel microfluidic devices

1	Microfluidic Technology - Introduction, definitions and applications
2	Materials for microfluidic device fabrication
3	Fabrication Techniques for Microfluidics, Soft Lithography Technique in detail
4	Laboratory session 1- wafer cleaning process
5	Laboratory session 2- Prime mould fabrication
6	Laboratory session 3- Replicas by casting
7	Laboratory session 4- Sealing of microchannel with a cover glass
8	Laboratory session 5- Leak testing
9	Laboratory session 6- Characterization of microchannels
10	CAD design of microchannels, Simulation of micro-mixers
11	Applications of microfluidics – recent reports

Total contact hours	**:**	**30**

Course Outcomes: On completion of the course, students will be able to

	understand the fundamentals of microfluidic technology.
	demonstrate the various fabrication techniques used in microfluidics.
	analyse the working and design of various microfluidic devices.
	design complex micro-mixers using CAD software.
	fabricate any microfluidic devices in real time

References:

1	Albert Folch, “Introduction to BioMEMS”, CRC press, Taylor and Francis group, 2013.
2	Yujun Song, Daojian Cheng, Liang Zhao, “Microfluidics: Fundamentals, Devices, and Applications”, Wiley VCH publications, 2018.
3	Patrick Tabeling, Suelin Chen,” Introduction to Microfluidics”, Oxford University press,first edition 2005, reprint 2011.
4	Suman Chakraborty, Microfluidics and Microfabrication, Springer, 2014, ISBN-10:9781489984609

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CR19P62.1	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
CR19P62.2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CR19P62.3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CR19P62.4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CR19P62.5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
Average	**3**	**2.8**	**2.6**	**2.8**	**2.4**	**2.4**	**2.2**	**1.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.6**	**2.8**	**3**

PROFESSIONAL ELECTIVE III

Subject Code	Subject Name	Category	L	T	P	C
EC19P71	COGNITIVE RADIO	PE	3	0	0	3

Objectives:

- To study the basics of the software defined radio
- To understand the fundamentals of cognitive radio
- To learn the necessity of software defined radio architecture in development of Cognitive Radio
- To know the concept of cognitive radio architecture
- To understand the concepts of wireless networks and next generation networks

UNIT-I	**SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE**	**9**

History of Software Defined Radio (SDR)- an overview, Basic SDR- Hardware architecture, Computational Processing Resources, Software architecture.

UNIT-II	**INTRODUCTION TO COGNITIVE RADIO**	**9**

Cognitive Radio (CR)- vision, history and definition, Java reflection in cognitive radio, smart antennas, spectrum management, spectrum access techniques.

UNIT-III	**SDR AS A PLATFORM FOR CR**	**9**

Introduction- Hardware architecture for SDR with DSP techniques- Software architecture, key development concepts and tools- SDR development and design, component development, waveform development- cognitive waveform development

UNIT-IV	**COGNITIVE RADIO ARCHITECTURE**	**9**

Cognitive Radio - functions, components and design rules, Cognition cycle - orient, plan, decide and act phases, Inference Hierarchy-Atomic Stimuli, Primitive Sequences, Basic Sequences Architecture maps.

UNIT-V	**NEXT GENERATION WIRELESS NETWORKS**	**9**

The XG Network architecture, spectrum sensing, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- Understand hardware and software architecture of SDR
- Analyze the functions of cognitive radio
- Design cognitive radio using SDR as a platform
- Development of architecture based on the functions of cognitive radio.
- Analyze the concepts behind the wireless networks and next generation networks

Text Books:

1. Bruce A. Fette, “Cognitive Radio Technology”, Elsevier, 2009.

Reference Books / Web links:

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. Thomas W.Rondeau, Charles W. Bostain, “Artificial Intelligence in Wireless communication”, ARTECH HOUSE .2009
4. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, “Next generation dynamic spectrum access / cognitive radio wireless networks: A Survey” Elsevier Computer Networks, May 2006.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P71.1	3	3	2	1	2	3	2	2	2	3	1	3	3	2	3
EC19P71.2	3	3	3	3	1	1	2	2	2	2	1	2	2	2	3
EC19P71.3	3	3	2	2	2	2	2	3	2	2	2	3	3	3	3
EC19P71.4	3	3	3	3	3	2	2	2	2	2	1	2	2	2	3
EC19P71.5	3	3	3	3	2	2	2	1	2	3	3	3	3	2	3
Average	3	3	2.6	2.4	2	2	2	2	2	2.4	1.6	2.6	2.6	2.2	3

Subject Code	Subject Name	Category	L	T	P	C
EC19P72	DIGITAL IMAGE PROCESSING	PE	3	0	0	3

Objectives:

- To learn digital image fundamentals.
- To be exposed to simple image enhancement techniques.
- To be exposed to simple image restoration techniques.
- To learn image segmentation.
- To be familiar with image compression techniques.

UNIT-I **DIGITAL IMAGE FUNDAMENTALS** **9**

Introduction - Steps in digital image processing, Components of digital image processing systems, brightness, contrast, hue, saturation, Image sensing and acquisition, Image sampling and quantization, Color image fundamentals.

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

Noise distributions, Histogram and Histogram equalization, Image enhancement - Gray level transformations, Spatial averaging, Directional smoothing, Homomorphic filtering and Color image enhancement.

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

Reasons for image degradation, Image restoration model, Restoration filters - Arithmetic mean, Geometric mean, Harmonic mean, Contra harmonic mean, median, midpoint, alpha trimmed, min and max filters, Adaptive mean filter, Adaptive median filter, Inverse filter and Wiener filter.

UNIT-IV **IMAGE SEGMENTATION** **9**

Detection of discontinuities - Point detection, Line detection, Edge detection, Detection of continuities – Thresholding, Adaptive thresholding, Region based segmentation, Region based segmentation - Region growing, Region splitting and Merging, Edge linking via Hough transform.

UNIT-V **IMAGE COMPRESSION** **9**

Need for data compression, Lossy and Lossless compression, Huffman coding, Run length codes, Shift codes, Arithmetic coding, Transform coding, JPEG and MPEG compression standards.

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Describe digital image fundamentals.
- Exhibit various image enhancement techniques.
- Exhibit various image restoration techniques.
- Explain various image segmentation techniques.
- Apply various image compression techniques.

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson, Second Edition, 2004.
2. Anil K. Jain, Fundamentals of Digital Image Processing', Pearson 2002.

Reference Books / Web links:

1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.
2. Jeyaraman, Esakki raja, 'Digital image processing', TATA Mcgraw Hill .2009.
3. William K. Pratt, , Digital Image Processing' , John Wiley, New York, 2002.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.
5. Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P72.1	3	2	2	2	2	1	1	2	2	2	1	1	1	1	2
EC19P72.2	3	2	2	2	3	2	1	2	2	2	2	2	2	3	3
EC19P72.3	3	2	2	2	3	2	1	2	2	2	2	2	3	3	3
EC19P72.4	3	3	3	3	3	2	1	2	2	2	2	3	3	3	3
EC19P72.5	3	2	2	2	2	3	1	2	2	2	2	3	2	2	3
Average	3	2.2	2	2.2	2.6	2	1	2	2	2	1.8	2.2	2.2	2.4	2.8

Subject Code	Subject Name	Category	L	T	P	C
MT19P76	ROBOTICS AND MACHINE VISION	PE	3	0	0	3

Objectives:

- To introduce the functional laws of robotics and their transmission systems
- The student will be exposed to the knowledge in different types end effectors based on their usage
- To outline the formal procedures for the analysis and design of sequential circuits
- To illustrate the concept of synchronous and asynchronous sequential circuits
- To introduce the concept of memories and programmable logic devices.

UNIT-I	BASICS OF ROBOTICS	9

Introduction- Basic components of robot-Laws of robotics- classification of robot-work space- accuracy-resolution – repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives.

UNIT-II	ROBOT END EFFECTORS	9

Robot End effectors: Introduction- types of End effectors- Mechanical gripper- types of gripper mechanism- gripper force analysis- other types of gripper- special purpose grippers.

UNIT-III	ROBOT MECHANICS	9

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- forward & inverse kinematics- trajectory planning. Robot Dynamics: Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation.

UNIT-IV	VISION FUNDAMENTALS AND ALGORITHMS	9

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces. Algorithms: Images, Regions, Sub-pixel Precise Contours – Image Enhancement: Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses.

UNIT-V	ROBOT PROGRAMMING AND APPLICATIONS	9

Introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV. Applications: Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms.

Total Contact Hours	:	45

Course Outcomes: After the successful completion of the course, the student will be able to:

- Apply the basic engineering knowledge and laws for the design of robotics
- Select suitable end effectors & grippers and tools' and sensors used in robots according to the requirements
- Develop kinematics, degeneracy, dexterity and trajectory planning
- understand the image capturing and processing techniques
- Develop programs using the application of vision and image processing in robot operations

Text Book (s):

1. Groover MP, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Second Edition, Tata McGraw-Hill Education Pvt Limited, 2017
2. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, Ingram short title; 2nd Revised edition, 2017
3. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, 2nd edition, 2018.

Reference Books(s) / Web links:

1. Ralph Gonzale, C.S.G. Lee K. S. Fu, "Robotics: Sensing, Vision & Intelligence", Tata McGraw- Hill Publication, 2008
2. John.J.Craig, " Introduction to Robotics: Mechanics & control" Pearson Publication, Fourth edition, 2018.
3. Donald P.Leach and Albert Paul Malvino, "Digital Principles and Applications", 8th Edition, TMH, 2014.
4. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000
5. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition – Wesley Publishing Company, New Delhi, 2007

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MT19P76.1	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
MT19P76.2	3	2	3	2	1	-	-	-	-	-	-	2	1	2	2
MT19P76.3	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2
MT19P76.4	3	-	-	1	2	-	-	-	-	-	-	-	2	2	2
MT19P76.5	-	3	3	3	3	2	2	-	-	-	-	3	3	3	3
Average	3	2.6	2.8	2.3	2	2	2	-	-	-	-	2.3	2	2.5	2.3

Subject Code	Subject Name	Category	L	T	P	C
EC19P73	**MIXED SIGNAL IC DESIGN**	PE	3	0	0	3

Objectives: The student should be made

- To understand the operating principle of CMOS amplifiers at different configurations.
- To study the fundamental methodologies for design and analysis of CMOS Operational Amplifiers and Comparators.
- To understand the concepts of D/A conversion methods and their architectures.
- To design filters for ADC.
- To understand the testing concepts in mixed signal VLSI circuits using statistical modelling.

UNIT-I **CMOS Amplifiers** **9**

Challenges in analog design-Mixed signal layout issues-Common Source with diode connected loads and current source load, Common Gate and Source Follower-Cascoded stages - Cascode amplifier with load.

UNIT-II **CMOS OP AMPS & Comparator** **9**

Two Stage Operational Amplifiers -Frequency compensation of OPAMPS - miller compensation**,** Characterization of a comparator-static and dynamic, AT wostage open loop comparator.

UNIT-III **DATA CONVERTERS** **9**

Characteristics of Sample and Hold- Digital to Analog Converters- architecture-Differential Non linearity-Integral Non linearity- Voltage Scaling-Cyclic DAC-Pipeline DAC-Analog to Digital Converters- architecture – Flash ADC-Pipeline ADC-Differential Non linearity-Integral Non linearity.

UNIT-IV **SNR IN DATA CONVERTERS** **9**

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC.

UNIT-V **MODELING AND SIMULATION OF MIXED SIGNAL DESIGN AND LAYOUT** **9**

Review of Statistical Concepts - Statistical Device Modeling using CAD- Statistical Circuit Simulation -Automation Analog Circuit Design-automatic Analog Layout-CMOS Transistor- Layout Resistor Layout-Capacitor Layout-Analog Cell Layout-Mixed Analog -Digital Layout.

Contact Hours : 45

Course Outcomes: On completion of the course, the students will be able to

- Understand the working of CMOS amplifiers in various configurations.
- Remember the design and analysis of CMOS Operational Amplifiers and Comparators.
- Apply the concepts of D/A conversion methods.
- Analyse and design various filters to improve SNR of DAC.
- Create Layout for mixed signal circuits and evaluate using CAD tool.

Text Books:

1. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2013.
2. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 5th Edition, Wiley Student Edition, 2009.

Reference Books:

1. VineethaP.Gejji Analog and Mixed Mode Design - Prentice Hall, 1st Edition , 2011.
2. JeyaGowri Analog and Mixed Mode Design- Sapna publishing House 2011.
3. B. Razavi, RF Microelectronics, Prentice-Hall PTR,1998
4. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University
5. Jose E.France, Yannis Tsividis, “Design of Analog-Digital VLSI Circuits for Telecommunication and signal Processing ", Prentice Hall, 1994

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P73.1	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
EC19P73.2	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
EC19P73.3	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
EC19P73.4	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**3**	**3**	**2**	**2**	**2**	**3**	**2**
EC19P73.5	**3**	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**3**	**3**	**2**	**3**	**3**	**3**	**2**
Average	**3**	**2.4**	**2**	**2.4**	**2**	**1**	**1**	**1**	**2.4**	**2.4**	**2.2**	**2.2**	**2.2**	**2.6**	**1.6**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
CR19P63	**ROBOTICS SYSTEM LABORATORY**	**PE**	**0**	**0**	**2**	**1**

Objectives:

●	To understand the basic functions of various sensor and actuators that can be integrated with the microcontroller.
●	To impart deep knowledge about embedded C language to handle complex problems
●	To develop clear knowledge on the hardware components used in robotic systems
●	To inculcate the habit of exploring and integrating latest add-ons to design innovative applications in robots
●	To develop and test different practical applications of robotic system

List of experiments

1	Basics of TI- Robotic System Learners Kit
2	Testing the working of MSP432 microcontroller
3	LED blinking and serial lights
4	Working of traffic lights using combinational programming of LEDs
5	Brightness control of LED using PWM technique
6	Display text and values using serial communication
7	Alert system using bump switches
8	Position detection using IR sensors
9	Motor speed control
10	Line follower robot
11	Maze solver robot
12	Racing robot along track

	Total contact hours	**:**	**30**

Course Outcomes: On completion of the course, students will be able to

●	integrate and assemble several sensors and actuators with the controller for customized robotic applications
●	debug and resolve software issues
●	troubleshoot and rectify hardware failure
●	design robots for innovative practical applications
●	program and control industrial robots
Reference	
1	Jonathan W. Valvano, "Embedded Systems-Introduction to Robotics", 1st Edition, Jonathan W. Valvano publications, 2019.
2	Jonathan W. Valvano, "Embedded Systems: Introduction to the MSP432 Microcontroller", (Volume 1) 1st Edition, 6th reprint, Jonathan W. Valvano publications, 2015.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CR19P63.1	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
CR19P63.2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CR19P63.3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CR19P63.4	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CR19P63.5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
Average	**3**	**2.8**	**2.6**	**2.8**	**2.4**	**2.4**	**2.2**	**1.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.6**	**2.8**	**3**

PROFESSIONAL ELECTIVE IV

Subject Code	Subject Name	Category	L	T	P	C
EC19P74	WIRELESS NETWORKS	PE	3	0	0	3

Objectives: The student should be made to

- To learn about Wireless networks, protocol stack and standards
- To study about mobile network layer functionalities
- To analyze about mobile transport layer functionalities
- To understand the fundamentals of 3G Services, its protocols and applications
- To discuss about evolution of 4G Networks, its architecture and applications, study the concept of Software defined radio.

UNIT-I **WIRELESS LAN** **9**

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, Protocol architecture, Physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager protocol, security - IEEE802.16-WIMAX: Physical layer, MAC.

UNIT-II **MOBILE NETWORK LAYER** **9**

Introduction - Mobile IP: IP packet delivery, Agent discovery, Tunneling and Encapsulation, IPV6Network layer in the internet-Mobile IP session initiation protocol - Mobile ad-hoc network: Routing, Destination sequence distance vector, Dynamic source routing.

UNIT-III **MOBILE TRANSPORT LAYER** **9**

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.

UNIT-IV **WIRELESS WIDE AREA NETWORK** **9**

Overview of UTMS Terrestrial Radio access network-UMTS core network architecture: 3G-MSC, 3GSGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High Speed Downlink Packet Access (HSDPA) - LTE network architecture and protocol.

UNIT-V **4G NETWORKS** **9**

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive modulation and coding with time slot scheduler, Software Defined Radio system.

Total Contact Hours : 45

Course Outcomes: On completion of course, students will be able to

- Conversant with the latest 3G/4G and Wi MAX networks and its architecture
- Discuss various layer functionalities in mobile networks.
- Design and implement wireless network environment for any application using latest wireless protocols and standards.
- Implement different type of applications for smart phones and mobile devices with latest network strategies.
- Identify the role of SDR in the next generation networks.

Text Books:

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.
2. Vijay Garg , "Wireless Communications and networking", First Edition, Elsevier 2007.

Reference Books / Web links:

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
2. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Ed., Elsevier 2011
3. Simon Haykin , Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013.

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P74.1	2	2	1	1	2	2	2	2	2	2	2	3	3	2	2
EC19P74.2	2	2	1	1	1	2	1	1	1	2	2	2	3	2	1
EC19P74.3	2	2	1	1	1	2	2	1	2	2	2	2	2	2	2
EC19P74.4	2	2	2	1	1	2	1	1	2	2	2	2	3	2	1
EC19P74.5	2	2	2	1	2	3	2	2	2	2	2	3	3	3	2
Average	2	2	1.4	1	1.4	2.2	1.6	1.4	1.8	2	2	2.4	2.8	2.2	1.6

Subject Code	Subject Name	Category	L	T	P	C
EC19P75	ADAPTIVE SIGNAL PROCESSING	PE	3	0	0	3

Objectives: The student should be made to

- To enrich the concepts related to stationary and non-stationary random signals
- To emphasize the importance of true estimation of power spectral density
- To design the linear filters for prediction
- To design the adaptive filters for noise and echo cancellation
- To introduce the concept of adaptive IIR filtering techniques in neural networks

UNIT-I	**DISCRETE RANDOM PROCESS**	**9**

Random variables, Random processes, Filtered random processes, Ensemble averages, Stationary and ergodic processes, correlation and covariance, White noise, Power Spectral Density, Spectral Factorization, Innovations Representation and Process, Filtering random processes, ARMA, AR and MA processes.

UNIT-II	**SPECTRUM ESTIMATION**	**9**

Bias and Consistency, Periodogram, Modified periodogram, Blackman-Tukey method, Welch method, Parametric methods of spectral estimation, Levinson-Durbin recursion.

UNIT-III	**LINEAR ESTIMATION AND PREDICTION**	**9**

Forward and Backward linear prediction, Filtering - FIR Wiener filter- Filtering and linear prediction

UNIT-IV	**ADAPTIVE FILTERS**	**9**

Principles of adaptive filter – FIR adaptive filter – Newton‘s Steepest descent algorithm – LMS algorithm – Adaptive noise cancellation, Adaptive equalizer, Adaptive echo cancellers.

UNIT-V	**ADAPTIVE IIR FILTERING TECHNIQUES**	**9**

Neural networks and multi-layer perceptrons, Adaptive IIR filtering, The constant modulus algorithm

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- To comprehend and appreciate the significance and role of this course in the present contemporary world
- To identify appropriate spectrum estimation method based on type of random signal
- To design of linear and adaptive systems
- To design filters for processing random signal
- To implement multi resolution approach for signals

Text Books:

1. Monson H, Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons Inc., New York, Indian Reprint, 2008.
2. Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition, 2014.

Reference Books / Web links:

1. 1. Sophocles J. Orfanidis, Optimum Signal Processing, An Introduction, McGraw Hill, 1990.
2. John G.Proakis, Dimitris G. Manolakis, Digital Signal Processing, Pearson, Fourth 2007.
3. Dwight F. Mix, Random Signal Processing, Prentice Hall, 1995.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P75.1	3	3	3	3	2	2	1	1	1	1	1	3	3	3	3
EC19P75.2	3	3	3	3	2	2	1	1	1	1	1	3	2	3	3
EC19P75.3	3	3	3	2	2	2	1	1	1	1	1	2	2	2	2
EC19P75.4	3	3	3	2	2	2	1	1	1	1	1	2	2	2	2
EC19P75.5	3	2	2	2	2	2	1	1	1	1	1	2	2	2	2
Average	3	2.8	2.8	2.4	2	2	1	1	1	1	1	2.4	2.2	2.4	2.4

Subject Code	Subject Name	Category	L	T	P	C
EC19P76	MULTIMEDIA COMPRESSION AND NETWORKING	PE	3	0	0	3

Objectives: The student should be made to

- Study basics components of multimedia.
- Analyse the characteristics of text and image data.
- Distinguish various compression schemes for voice and video.
- Measure the performance of multimedia networking.
- Evaluate Voice over IP technology.

UNIT-I **BASICS OF MULTIMEDIA COMPONENTS** **9**

Introduction - Multimedia skills - Multimedia components and their characteristics - Text, sound, images, graphics, animation, video, hardware.

UNIT-II **TEXT AND IMAGE COMPRESSION** **9**

Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding -text compression –static Huffman coding dynamic coding – arithmetic coding –Lempel Ziv-Welch Compression-image compression.

UNIT-III **AUDIO AND VIDEO COMPRESSION** **9**

Audio compression–DPCM-Adaptive DPCM –adaptive predictive coding-linear Predictive coding-code excited LPC-perpetual coding Video compression –principles-H.261-H.263-MPEG 1, 2, and 4.

UNIT-IV **MULTIMEDIA NETWORKING** **9**

Multimedia networking -Applications-streamed stored and audio-making - Best Effort service-protocols for real time interactive Applications-distributing multimedia-beyond best effort service-secluding and policing Mechanisms-integrated services-differentiated Services-RSVP.

UNIT-V **VOIP TECHNOLOGY** **9**

Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service- CODEC Methods- VOIP applicability

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Understand various multimedia components.
- Compare the various compression techniques for text and image data.
- Explore the compressions and decompressions of multimedia content.
- Assess the quality of service provided by multimedia networking.
- Examine VOIP challenges and its technologies.

Text Books:

1. Fred Halshall “Multimedia communication - Applications, Networks, Protocols and Standards”, First edition, Pearson Education, 2007.
2. Tay Vaughan, “Multimedia: Making It Work”, 7/e, TMH, 2007.

Reference Books / Web links:

1. Kurose and W.Ross “Computer Networking: A Top Down Approach”, 6 edition, Pearson Education, 2013.
2. Marcus Goncalves “Voice over IP Networks”, Mc Graw hill, 1999.
3. KR. Rao, Z S Bojkovic, D A Milovanovic, “Multimedia Communication Systems: Techniques, Standards and Networks”, Pearson Education India, 2007.
4. R. Steimnetz, K. Nahrstedt, “Multimedia Computing, Communications and Applications”, Pearson Education, First edition, 1995.
5. Ranjan Parekh, “Principles of Multimedia”, 2 edition, TMH, 2012.

Web links for virtual lab:

1. http://rad.ihu.edu.gr/index.php?id=55
2. https://hmiuet.wordpress.com/video-coding/

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P76.1	2	2	2	2	2	2	3	1	2	3	1	3	2	2	1
EC19P76.2	3	3	2	3	3	2	3	1	2	3	3	3	2	3	3
EC19P76.3	3	3	3	3	3	3	2	1	2	2	3	3	3	3	3
EC19P76.4	2	2	3	3	3	2	2	1	2	3	3	3	2	3	2

EC19P76.5	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**3**	**3**	**3**	**2**	**3**	**3**
Average	**2.4**	**2.6**	**2.6**	**2.8**	**2.8**	**2.4**	**2.4**	**1**	**2**	**2.8**	**2.6**	**3**	**2.2**	**2.8**	**2.4**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19P77	**COMPREHENSIVE COURSE ON ECE**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To remember the concepts of electronic circuits
- To understand the Boolean concepts in the design of digital circuits
- To implement the digital circuits using signal processing concepts
- To remember the field theory concepts for the design of Antennas
- To understand the fundamentals of communication theory

UNIT-I **FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS** **9**

Energy bands in Intrinsic and Extrinsic semiconductors, diffusion and drift current, PN junction and Zener diode characteristics, applications of junction diode (Half wave and full wave rectifier, positive clipper & clamper). BJT biasing (self and voltage divider bias), JFET and MOSFET –drain and transfer characteristics. Ideal op-amp, Inverting and Non-Inverting Amplifiers, Differential amplifier, Instrumentation amplifier, Integrator, Differentiator, Comparator, Active filters, Schmitt trigger.

UNIT-II **DIGITAL AND VLSI DESIGN** **9**

Number representations, Boolean theorems, Minimization of Boolean expressions, Logic gates, design of combinational circuit (multiplexer, encoder, decoder). Design of synchronous sequential circuits (Flip flops, Counters, Shift registers), CMOS inverter, Overview of static and dynamic CMOS, power dissipation.

UNIT-III **SIGNAL PROCESSING** **9**

Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Classifications of signals and systems: Elementary signals, Fourier transform, Discrete Fourier Transform, Fast Fourier transform -Analysis of systems using Laplace transform and Z transform-Design of FIR and IIR filters.

UNIT-IV **ELECTROMAGNETICS** **9**

Electromagnetics: Maxwell's equations, boundary conditions, wave equation, Poynting vector; polarization, phase and group velocity, skin depth. **Transmission lines:** Equations, characteristic impedance, impedance matching. Rectangular Waveguides: modes, boundary conditions cut-off frequencies. **Antennas:** Types, radiation pattern, gain and directivity, return loss.

UNIT-V **FUNDAMENTALS OF COMMUNICATION SYSTEMS** **9**

Introduction to modulation, AM: Balanced modulator and envelope detector. Fundamental concept of DSBSC, SSB and VSB. FM: Amstrong method & Frequency discrimination. Measure of Information, Entropy, Channel Capacity. Study of DM and ADM. BER performance comparative study of Coherent BPSK, BFSK & QPSK and QAM . Cyclic codes, Convolutional codes (with simple illustrations).

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Analyze electronic circuits for hardware implementation
- Design combinational and sequential circuits
- Analyze the LTI systems
- Describe the properties of various antennas
- Apply the communication principles in various applications

Reference Books / Web links:

1. David A.Bell, "Electronic Devices and Circuits", Oxford Higher Education Press, 5th Edition, 2010.
2. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
3. Allan V. Oppenheim, S.Wilsky and S. H. Nawab, "Signals and Systems", Pearson Education, 2007.
4. John G. Proakis&Dimitris G. Manolakis, "Digital Signal Processing-Principles, Algorithms and Applications", Fourth edition, Pearson Education/Prentice Hall, 2007.
5. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4th Edition, Oxford University Press Inc. First India edition, 2009.
6. John D Ryder, "Networks, lines and fields", 2nd Edition, Pearson Education India, 2015.
7. John D Kraus, Ronald J Marhefka, Ahmed S Khan, "Antennas and Wave Propagation", McGraw Hill, 5th Edition, 2017.
8. M. Morris Mano and Michael D. Ciletti, ―Digital Design‖, 5th Edition, Pearson, 2014.
9. Jan M. Rabaey ,Anantha Chandrakasan, Borivoje. Nikolic, Digital Integrated Circuits: A Design perspective, Second Edition , Pearson , 2016

10	Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, ―The 8051 Microcontroller and Embedded Systems: Using Assembly and C‖, Second Edition, Pearson education, 2011.
11	Neil H.E. Weste, David Money Harris ―CMOS VLSI Design: A Circuits and Systems Perspective‖, 4th Edition, Pearson , 2017
12	A.K. Ray, K.M. Bhurchandi, ―Advanced Microprocessor and Peripherals, Second edition, Tata McGraw-Hill, 2010.
13	Simon Haykin, Communication Systems, John Wiley & sons, NY, 4th Edition, 2001.
14	S. Haykin, "Digital Communications", John Wiley, 2005
15	Rappaport,T.S., "Wireless communications", Second Edition, Pearson Education, 2010.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P77.1	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**	**3**		
EC19P77.2	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**	**3**	**2**	
EC19P77.3	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**		**2**	
EC19P77.4	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**			**3**
EC19P77.5	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**			**3**
Average	**3**	**3**	**3**	**3**			**1**	**1**	**1**	**1**	**1**	**2**	**3**	**2**	**3**

PROFESSIONAL ELECTIVE V

Subject Code	Subject Name	Category	L	T	P	C
EC19P81	ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS	PE	3	0	0	3

Objectives:

- To understand Artificial Intelligence and searching algorithms
- To learn to represent knowledge in solving Artificial Intelligence problems
- To understand Artificial Neural Networks and the learning laws
- To analyse and apply feed forward networks for building Associative Memory models
- To evaluate Artificial Intelligence and Artificial Neural Networks models for real world applications

UNIT-I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9

Introduction - Foundation and history of Artificial Intelligence. Artificial Intelligence Problems and techniques - Artificial Intelligence programming languages – problem spaces and searches -Blind search strategies; Breadth first - Depth first –Heuristic search techniques Hill climbing - Best first – A* algorithm AO* algorithm

UNIT-II	KNOWLEDGE REPRESENTATION	9

Knowledge representation issues – Predicate logic – logic programming – Semantic nets - Frames and inheritance - constraint propagation –Representing Knowledge using rules – Rules based deduction system.

UNIT-III	INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS AND LEARNING LAWS	9

Artificial neural networks and their biological motivation – Terminology – Models of neuron – Topology – characteristics of artificial neural networks – types of activation functions- Learning methods – error correction learning – Hebbian learning – Perceptron – XOR Problem

UNIT-IV	FEED FORWARD NETWORKS AND RECURRENT NEURAL NETWORKS	9

Multilayer Perceptron – Back Propagation learning algorithm – Universal function approximation – Associative memory: auto association, hetero association, recall and cross talk– Hopfield neural network – Travelling Salesman Problem

UNIT-V	APPLICATIONS OF ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS	9

Artificial Intelligence application to Natural Language Processing - Artificial Intelligence application to robotics-Current trends in Intelligent Systems-Applications of neural networks in image processing, signal processing

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Develop an ability to analyze and formalize the problem and select the appropriate search method.
- Apply various knowledge representation for issues
- Solve the logical function with Artificial Neural Network and will be able to differentiate artificial neuron and human brain
- Summarize the recurrent neural networks and demonstrate the back propagation learning algorithm
- Design various applications that use Artificial Intelligence and Neural Networks

Text Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” Fourth Edition, Pearson, 2019.
2. S. Haykin, “Neural Networks and Learning Machines”, Third Edition, Pearson, 2019.

Reference Books / Web links:

1. Patrick Henry Winston, “Artificial Intelligence”, Third Edition, Pearson, 2009.
2. George F Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Sixth Edition, Pearson, 2008.
3. B. Yegnanarayana, “Artificial Neural Networks”, PHI, 2006.
4. Jacek. M. Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, 2006.
5. Simon Haykin, “Neural Networks: A Comprehensive Foundation”, Third Edition, Prentice Hall, 2007.
6. https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_natural_language_processing.htm
7. https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_robotics.htm
8. http://cbcl.mit.edu/people/poggio/journals/chellappa-poggio-IEEE-1998.pdf
9. https://papers.nips.cc/paper/284-a-neural-network-for-real-time-signal-processing.pdf

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P81.1	3	1	-	3	2	1	2	1	1	2	-	1	3	2	2
EC19P81.2	3	3	2	2	3	2	2	1	1	2	-	1	3	3	2
EC19P81.3	3	3	2	3	3	3	2	1	1	2	-	1	3	3	2
EC19P81.4	3	3	2	2	3	3	2	1	1	2	-	1	3	3	3

EC19P81.5	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**3**	**-**	**1**	**3**	**3**	**2**
Average	**3**	**2.6**	**1.8**	**2.6**	**2.8**	**2.4**	**2**	**1**	**1**	**2.2**	**0**	**1**	**3**	**2.8**	**2.2**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19P82	**ESSENTIALS OF CRYPTOGRAPHY AND NETWORK SECURITY**	**PE**	**3**	**0**	**0**	**3**

Objectives: The student should be made to

- Learn basics of encryption and modern cryptography.
- Understand methods of public key encryption.
- Learn authentication and hash functions.
- Know the Techniques of system level securities.
- Have knowledge on current trends on wireless security.

UNIT-I **INTRODUCTION** **9**

Services, Mechanisms and attacks-the OSI security architecture-Network security model-Classical Encryption techniques Symmetric cipher model, substitution techniques, transposition techniques, steganography. Finite Fields: Groups, Rings, Fields-Modular arithmetic-Euclid's Algorithm-Finite fields. Number Theory: Fermat's and Euler's Theorem- Chinese Remainder Theorem.

UNIT-II **BLOCK CIPHERS & PUBLIC KEY CRYPTOGRAPHY** **9**

Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES. Public key cryptography: Principles of public key cryptosystems-The RSA algorithm-Key management-Attacks on RSA - Diffie Hellman Key exchange.

UNIT-III **HASH FUNCTIONS AND DIGITAL SIGNATURES** **9**

Application of Hash Functions – Two simple Hash Functions-Requirements and Security – Hash Function based Cipher Block Chaining – Secure Hash Algorithm (SHA), Message Authentication Codes – Requirements and Security of MACs, HMAC– Digital Signatures and Authentication Protocols – Digital Signature Standards.

UNIT-IV **SECURITY PRACTICE & SYSTEM SECURITY** **9**

Authentication applications – Kerberos – X.509 Authentication services – Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of Firewalls – Firewall designs – SET for E-Commerce Transactions. Intruder – Intrusion detection system – Virus and related threats – Countermeasures – Firewalls design principles – Trusted systems – Practical implementation of cryptography and security

UNIT-V **E-MAIL, IP, WEB & WIRELESS LAN SECURITY** **9**

E-mail Security: Security Services for E-mail-attacks possible through E-mail - establishing keys privacy-authentication of the source-Message Integrity-Nonrepudiation-Pretty Good Privacy-S/MIME. IPSecurity: Overview of IPSec - IP and IPv6-Authentication Header-Encapsulation Security Payload (ESP)-Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding). Web Security: SSL/TLS Basic Protocol-computing the keys- client authentication- Wireless LAN Security: Wi-Fi Protected Access (WPA)

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- The methods of conventional encryption and modern cryptography.
- The concepts of Public Key Encryption.
- Methodology for Authentication and Hashing.
- Comprehending System Level Securities.
- Perceiving Wireless Security.

Text Books:

1 William Stallings , Cryptography and Network Security-Principles and Practices, Eighth Edition, Pearson Education, 2020

2 Forouzan, Cryptography and Network Security, Third Edition , Mc Graw Hill India, 2015.

3 Charlie Kaufman, "Network Security Private Communication in Public World" 2nd edition, Prentice Hall of India New Delhi, 2004.

Reference Books / Web links:

1 William Stallings, "Network Security Essentials", 6th edition, Prentice Hall of India New Delhi, 2017.

2 Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security", Prentice Hall of India, 2002

3 AtulKahaet, Cryptography and Network Security, Fourth Edition, Tata McGraw-Hill, 2019

4 Bruce Schneier , Applied Cryptography: Protocols, Algorithms and Source Code in C, Special Edition, Wiley, 2015

5 JoxeanKoret and Elias Bachaalany, The Antivirus Hackers Handbook, First Edition, Wiley, 2015

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P82.1	3	3	2	1	1	2	1	1	1	2	1	2	2	1	2
EC19P82.2	3	2	2	1	2	1	1	1	2	2	2	2	2	2	2
EC19P82.3	3	2	2	2	3	1	2	1	2	2	2	2	2	2	2
EC19P82.4	3	2	2	2	3	2	2	2	2	2	2	2	2	2	2
EC19P82.5	3	2	3	3	3	3	3	2	3	2	2	3	3	2	3
Average	3	2.2	2.2	1.8	2.4	1.8	1.8	1.4	2	2	1.8	2.2	2.2	1.8	2.2

Subject Code	Subject Name	Category	L	T	P	C
EC19P83	INTRODUCTION TO IoT	PE	3	0	0	3

Objectives: The student should be made

- To understand the fundamentals of Internet of Things
- To learn about IoT Architecture
- To learn about the basics of IOT protocols
- To build a small low-cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real-world scenario.

UNIT-I INTRODUCTION — **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT-II IoT ARCHITECTURE — **9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT-III IoT PROTOCOLS — **9**

IoT Access Technologies: Physical and MAC Layers, Topology and Security of IEEE 802.15.4, 1901.2a, 802.11ah and LoRaWAN – Network Layer: Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo.

UNIT-IV BUILDING IoT WITH RASPBERRY PI & ARDUINO — **9**

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT-V APPLICATION AND CASE STUDIES — **9**

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style – Case study.

Total Contact Hours : 45

Course Outcomes: On completion of the course, students will be able to

- Identify the architecture of IoT
- Analyze the various protocols for IoT
- Design a portable IoT using Raspberry Pi
- Deploy an IoT application and connect to the cloud.
- Identify and design the new models for market strategic interaction.

Text Book(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, CISCO Press, 2017.
2. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015

Reference Books(s) / Web links:

1. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.

	3	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
	4	Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P83.1	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**
EC19P83.2	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**
EC19P83.3	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**
EC19P83.4	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**
EC19P83.5	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**
Average	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EC19P84	WAVELETS	PE	3	0	0	3

Objectives:

- To familiarize with wavelet theory and signal representation.
- To learn about CWT and its properties
- To construct discrete wavelet transform by designing filter banks.
- To study the significance of wavelets in multi resolution analysis.
- To implement wavelet transform in various applications.

UNIT-I	INTRODUCTION	9

Stationary and non-stationary signals, Signal representation using basis and frames, Brief introduction to Fourier transform and Short time Fourier transform, Time-frequency analysis, Bases of time frequency: orthogonal, Filter banks, Multi resolution formulation: Wavelets from filters, Classes of wavelets: Haar, Daubechies, bi-orthogonal.

UNIT-II	CONTINUOUS WAVELET TRANSFORM	9

Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Inverse continuous wavelet transform, Redundancy of CWT, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet transform domain.

UNIT-III	DISCRETE WAVELET TRANSFORM AND FILTERBANKS	9

Orthogonal and bi-orthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Non-linear approximation in the Wavelet domain, multi resolution analysis, Construction and Computation of the discrete wavelet transform, the redundant discrete wavelet transform

UNIT-IV	MULTI RESOLUTION ANALYSIS	9

Multirate discrete time systems, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two dimensional, wavelet transforms and Extensions to higher dimensions, wave packets.

UNIT-V	APPLICATIONS	9

Signal and Image compression, Detection of signal changes, analysis and classification of audio signals using CWT, Adaptive wavelet techniques digital Communication and Multicarrier Modulation, Trans multiplexers.

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Understand the terminology that is used in the wavelets literature.
- Analyze the time frequency representation of CT signals using CWT
- Apply DWT for multi resolution analysis
- Analyze wavelet and packet decomposition concepts for signal processing techniques
- Apply wavelets and multi resolution techniques to a problem at hand tool.

Text Books:

1. A Wavelet Tour of Signal Processing, 2nd edition, S. Mallat, Academic Press, 1999.
2. Wavelets and Sub band Coding, M. Vetterli and J. Kovacevic, Prentice Hall, 1995.
3. Wavelet transforms: Introduction, Theory and applications, Raghuveerrao and AjitS.Bopardikar, Pearson Education Asia, 2000.

Reference Books / Web links:

1. Fundamentals of Wavelets: Theory, Algorithms, and Applications, J.C. Goswami and A.K. Chan, 2nd ed.,Wiley, 2011.
2. Wavelets and their Applications, Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, John Wiley & Sons, 2010.
3. A premier on Wavelets and their scientific applications, J S Walker, CRC press, 2002.
4. Wavelets and signal processing: An application based introduction, Stark, Springer, 2005.
5. A friendly guide to Wavelets, Gerald keiser, Springer, 2011.
6. Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson Education, 2004.
7. Wavelets : from math too practice, Desanka.P.Radunovik, springer, 2009

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19P84.1	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**3**	**2**	**3**	**3**	**3**	**2**
EC19P84.2	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**
EC19P84.3	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**3**	**2**	**3**	**2**
EC19P84.4	**2**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**	**3**
EC19P84.5	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**3**	**2**
Average	**2.8**	**2.6**	**2.6**	**2.4**	**1**	**1**	**-**	**-**	**3**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**2.2**

PROFESSIONAL ELECTIVE VI

Subject Code	Subject Name	Category	L	T	P	C
EC19P85	WIRELESS SENSOR NETWORKS	PE	3	0	0	3

Objectives: The student should be made to

- Know the basic knowledge about wireless sensor networks
- Understand the basics of sensor architecture
- Describe the different strategies used to develop MAC and routing protocols for the sensor networks.
- Learn the basic concepts involved in localization and synchronization of WSN.
- Have an exposure to Ad Hoc networks

UNIT-I	**OVERVIEW OF WIRELESS SENSOR NETWORKS**	**8**

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Comparison with ad hoc network, Applications of Wireless Sensor Networks.

UNIT-II	**ARCHITECTURES**	**9**

Single-node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture – Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-III	**NETWORKING SENSORS**	**10**

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts – S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

UNIT-IV	**INFRASTRUCTURE ESTABLISHMENT**	**9**

Topology Control, Clustering, Time Synchronization, Localization and Positioning – Properties, Approaches and Mathematical basics for single hop and multi-hop environment, Sensor Tasking and Control.

UNIT-V	**OVERVIEW OF AD HOC NETWORKS**	**9**

Introduction to Ad hoc networks – Cellular and Ad Hoc wireless networks, Applications of Ad Hoc wireless networks, Issues in designing a Routing Protocols for Ad hoc Wireless Networks, Classification of Routing protocols – Table driven – DSDV, On demand- Dynamic Source Routing (DSR)

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- Know the basics of Wireless Sensor Networks
- Understand the architecture of WSN.
- Apply this knowledge to identify the suitable MAC layer protocol and routing algorithm based on the network and user requirement
- Understand the localization and synchronization of sensor networks.
- Understand the basics of Ad Hoc Networks.

Text Books:

1. Holger Karl & Andreas Willig, “Protocols And Architectures for Wireless Sensor Networks”, John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach”, Elsevier, 2007.
3. Murthy, C. Siva Ram, and B. S. Manoj. Ad hoc wireless networks: Architectures and protocols, portable documents. Pearson education, 2004.

Reference Books / Web links:

1. Kazem Sohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks Technology, Protocols, And Applications”, John Wiley, 2007.
2. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.
3. Edgar H. Callaway, Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols," CRC Press, August 2003.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
EC19P85.1	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**1**
EC19P85.2	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**2**	**1**
EC19P85.3	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**3**	**2**	**3**	**3**	**2**
EC19P85.4	**3**	**2**	**3**	**3**	**3**	**1**	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**3**	**2**
EC19P85.5	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**1**
Average	**3**	**1.4**	**1.8**	**2.0**	**1.6**	**1.6**	**1.4**	**1.0**	**1.2**	**1.6**	**2.0**	**2.0**	**3**	**2.0**	**1.4**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EC19P86	**RADAR AND NAVIGATIONAL AIDS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To understand the basic principle of operation and parameters of radar.
- To study the principle of operation of moving target detector and tracking radar.
- To acquire knowledge about radar signal propagation and processing.
- To learn principles of antennas and propagation related to radars.
- To understand the principles of navigation and landing aids related to navigation.

UNIT-I **INTRODUCTION TO RADAR EQUATION** **9**

Introduction- Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Applications of Radar - Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio- Probabilities of Detection and False Alarm- Transmitter Power-Pulse Repetition Frequency- Antenna Parameters.

UNIT-II **MTI AND PULSE DOPPLER RADAR** **9**

Introduction to Doppler and MTI Radar- Delay –Line Cancellers- Staggered Pulse Repetition Frequencies –Doppler Filter Banks - Moving Target Detector – Pulse Doppler Radar – Monopulse Tracking –Conical Scan and Sequential Lobing.

UNIT-III **DETECTION OF SIGNALS IN NOISE** **9**

Matched –Filter Receiver –Detection Criteria – Detectors –-Automatic Detector - Integrators - Constant- False-Alarm Rate Receivers - The Radar operator - Signal Management - Propagation Radar Waves - Atmospheric Refraction -Standard propagation - Nonstandard Propagation.

UNIT-IV **ANTENNAS FOR DETECTION OF RADAR SIGNALS** **9**

The Radar Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas – Cosecant Squared Array, Phase Shifters - Frequency-Scan Arrays, Radome.

UNIT-V **RADIO NAVIGATION** **9**

Introduction - Four methods of Navigation .- The Loop Antenna - The Goniometer - Errors in Direction Finding - Adcock Direction Finders - Direction Finding at Very High Frequencies - Automatic Direction Finders – The Commutated Aerial Direction Finder - Range and Accuracy of Direction Finders - The LF/MF Four course Radio Range - VHF Omni Directional Range (VOR) - VOR Receiving Equipment - Range and Accuracy of VOR – Recent Developments. Hyperbolic Systems of Navigation (Loran and Decca) - Loran-A - Loran-A Equipment - Range and precision of Standard Loran - Loran-C - The Decca Navigation System -Decca Receivers - Range and Accuracy of Decca - The Omega System

Total Contact Hours : 45

Course Outcomes: On completion of course students will be able to

- Derive and discuss the radar equation and related parameters.
- Apply the principle of Doppler for detecting moving targets.
- Process and analyse radar signals influenced by various propagation mechanisms.
- Compare and contrast variety of antennas used for radar applications.
- Demonstrate the principles of navigation and landing aids.

Text Books:

1. Merrill I. Skolnik,“Introduction to Radar Systems”, Third edition, Tata McGraw-Hill 2003.
2. N.S.Nagaraja, “Elements of Electronic Navigation Systems”, Second Edition, TMH, 2000.

Reference Books / Web links:

1. Peyton Z. Peebles:, "Radar Principles", John Wiley, 2004.
2. J.C Toomay, "Principles of Radar", Second Edition –PHI, 2004.

PO/PSO CO	PO 1	PO2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P86.1	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19P86.2	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19P86.3	3	3	3	2	1	1	1	1	2	2	3	3	2	3	3
EC19P86.4	3	3	3	2	1	1	1	1	2	2	3	3	3	3	3
EC19P86.5	3	3	2	3	2	1	1	1	2	2	3	3	2	3	3
Average	3	3	2.8	2.2	1.2	1	1	1	2	2	3	3	2.2	3	3

Subject Code	Subject Name	Category	L	T	P	C
EC19P87	MACHINE LEARNING AND DEEP LEARNING	PE	3	0	0	3

Objectives:

- To understand the basic concepts of Machine learning
- To analyse and evaluate various Machine learning Algorithms
- To understand the basic concepts of Deep learning
- To understand and analyse Deep learning Algorithms
- To apply machine learning and deep learning models for real world applications

UNIT-I	INTRODUCTION TO MACHINE LEARNING	9

Definition of Machine Learning models- Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation-Inductive Classification-The concept learning task-Concept learning as search through a hypothesis space-General-to-specific ordering of hypotheses

UNIT-II	MACHINE LEARNING ALGORITHMS	9

Decision Tree Learning-Representing concepts as decision trees-Recursive induction of decision trees-Picking the best splitting attribute: entropy and information gain-Searching for simple trees and computational complexity. Support Vector Machines-Maximum margin linear separators-Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions

UNIT-III	INTRODUCTION TO DEEP LEARNING	9

Feedforward Neural networks. Gradient descent and the backpropagation algorithm-Relu-Heuristics for avoiding bad local minima-Heuristics for faster training- *Nesterov* accelerated gradient descent-Regularization-Dropout.

UNIT-IV	DEEP LEARNING ALGORITHMS	9

CNN-Architectures, convolution / pooling layers- RNNs-LSTM, GRU, Encoder Decoder architecture- Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder

UNIT-V	APPLICATIONS OF MACHINE LEARNING AND DEEP LEARNING	9

Applications of Machine Learning in Text Classification-Applications of Deep Learning-Image segmentation, object detection

Total Contact Hours	:	45

Course Outcomes: On completion of course students will be able to

- Understand the basic concepts of Machine learning
- Analyse and evaluate various Machine learning Algorithms
- Understand the basic concepts of Deep learning
- Understand and analyse Deep learning Algorithms
- Apply machine learning and deep learning models for real world applications

Text Books:

1. Tom Mitchell,Machine Learning, McGraw Hill, 1997.
2. Ian J. Goodfellow,YoshuaBengio and Aaron Courville. "Deep learning." An MIT Press book in preparation. (2015)..

Reference Books :

1. EthemAlpaydin, Introduction to Machine Learning, The MIT Press (2014)
2. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.
3. Hochreiter, Sepp, and Jargen Schmidhuber. "Long short-term memory." Neural computation 9.8 (1997): 17351780.
4. https://towardsdatascience.com/automated-text-classification-using-machine-learning-3df4f4f9570b
5. https://missinglink.ai/guides/computer-vision/image-segmentation-deep-learning-methods-applications/
6. https://towardsdatascience.com/deep-learning-for-object-detection-a-comprehensive-review-73930816d8d9

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P87.1	**3**	**1**	**-**	**3**	**2**	**1**	**3**	**2**	**1**	**2**	**-**	**1**	**3**	**2**	**2**
EC19P87.2	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**2**
EC19P87.3	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**2**
EC19P87.4	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**1**	**3**	**3**	**3**
EC19P87.5	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**1**	**3**	**3**	**2**
Average	**3**	**2.6**	**1.8**	**2.6**	**2.8**	**2.4**	**2.2**	**2**	**1.4**	**2.2**	**0**	**1**	**3**	**2.8**	**2.2**

Subject Code	Subject Name	Category	L	T	P	C
EC19P88	SATELLITE COMMUNICATION	PE	3	0	0	3

Objectives:

- To understand the basics of satellite orbits
- To describe the satellite space and earth segments.
- To analyze the satellite uplink and downlink design
- To discuss various methods of satellite access.
- To understand the applications and services of satellites

UNIT-I	**SATELLITE ORBITS**	**9**

Kepler's Laws, orbital parameters, orbital elements, apogee and perigee heights, orbital perturbations, The geo stationary orbit – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Orbits

UNIT-II	**SPACE SEGMENT AND EARTH SEGMENT**	**9**

Space Segment - The power Supply, Attitude control, Station Keeping, Thermal control, Telemetry, Tracking and command Subsystem, Transponders, Earth Segment - Receive – Only home TV systems, Master antenna TV system – Community antenna TV system – Transmit – Receive earth stations..

UNIT-III	**SATELLITE LINK DESIGN**	**9**

Introduction - Equivalent isotropic radiated power – Transmission losses – Free-space transmission – Feeder losses – Antenna misalignment losses – Fixed atmospheric and ionospheric losses – Link power budget equation – System noise – Antenna noise – Amplifier noise temperature – Amplifiers in cascade – Noise factor – Noise temperature of absorptive networks – Overall system noise temperature – Carrier to- Noise ratio – Uplink – Saturation flux density – Input back off – The earth station - HPA – Downlink – Output back off – Satellite TWTA output – Effects of rain – Uplink rain– Fade margin – Downlink rain – Fade margin – Combined uplink and downlink C/N ratio – Inter modulation noise.

UNIT-IV	**SATELLITE ACCESS**	**9**

Introduction, multiple access: Preassigned FDMA, Demand-Assigned FDMA, Spade System, TDMA – Reference burst, Preamble and Postamble, Carrier Recovery, Network Synchronization, Unique Word Detection, Traffic Data, Frame Efficiency and Channel Capacity, Preassigned TDMA, Demand-Assigned TDMA. CDMA - DSSS, The code signal, The Autocorelation function, Acquisition and tracking, Spectrum spreading and dispreading, CDMA throughput.

UNIT-V	**SATELLITE SERVICES**	**9**

Direct Broadcast Satellite Services – Introduction, Orbital Spacings, Power Rating and Number of Transponders, Frequencies and Polarization, Transponder Capacity, Bit Rates for Digital Television, MPEG Compression Standards, Forward Error Correction, Home Receiver Outdoor Unit (ODU), Home Receiver Indoor Unit (IDU). Satellite Mobile Services – VSATs – Radarsat – Global Positioning Satellite System – Orbcomm

Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to

- Describe the satellite orbits and launching procedures
- Demonstrate the earth segment and space segment components to measure G/T, C/N, EIRP, antenna gain.
- Analyze the satellite uplink and downlink performance to calculate E/N ratio and construct the link budget table.
- Discuss the various multiple user techniques like FDMA, TDMA, CDMA
- Analyze the satellite services such as DBS, GPS and Satellite Mobile Services

Text Books:

1. Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2006.

Reference Books / Web links:

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.
3. Bruce R. Elbert, "The Satellite Communication Applications", Hand Book, Artech House Bostan London, 1997.
4. Tri T. Ha, "Digital Satellite Communication", II nd edition, 1990.
5. Emanuel Fthenakis, "Manual of Satellite Communications", Mc Graw Hill Book Co., 1984.
6. Robert G. Winch, "Telecommunication Trans Mission Systems", Mc Graw-Hill Book Co., 1983.
7. Brian Ackroyd, "World Satellite Communication and earth station Design", BSP professional Books, 1990.

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC19P88.1	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**1**
EC19P88.2	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**3**	**2**	**1**
EC19P88.3	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
EC19P88.4	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**3**	**3**	**1**
EC19P88.5	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
Average	**2.6**	**2.8**	**2.6**	**2.2**	**2**	**2.2**	**2**	**1.4**	**1.6**	**2.4**	**2**	**2.2**	**2.8**	**2.6**	**1.4**