GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

Regulations, Curriculum and Syllabi For
B.E. (ELECTRONICS AND COMMUNICATION ENGINEERING)
(Full Time)

2018
Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
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GOVERNMENT COLLEGE OF TECHNOLOGY

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind.

MISSION

- To achieve Academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

The vision of ECE department is to become pioneer in higher learning and research and to produce creative solution to societal needs.

MISSION

1. To provide excellence in education, research and public service.
2. To provide quality education and to make the students entrepreneur and employable.
3. Continuous upgradation of techniques for reaching heights of excellence in a global perspective.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES

The Program Educational Objectives (PEO's) of Electronics and Communication Engineering are

PEO1: Graduates apply their knowledge of mathematics and science to identify, analyze and solve problems in the field of Electronics and develop sophisticated communication systems.

PEO2: Graduates exhibit their innovative ideas and management skills to meet the day to day technical challenges.

PEO3: Graduates embody a commitment to professional ethics, diversity and social awareness in their professional career.

PEO4: Graduates exhibit a desire for life-long learning through technical training and professional activities.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAMME OUTCOMES

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/Development of solutions:** Design solution 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 culture, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretations of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, Select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environmental and sustainability:** Understanding the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management and finance principles and apply these to one's own work, as a member and leader in a team, to manage projects and multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAMME SPECIFIC OUTCOME

PSO1: Graduates will be able to understand and apply the concepts of Electronics and Communication Engineering in the field of Microelectronics, Signal processing, Communication/Networking, Embedded and VLSI Systems.

PSO2: Graduates will be able to design and utilize advanced Hardware and Software tools to analyze and implement subsystems/processes for real time applications.

PSO3: Graduates will be able to apply domain knowledge to enhance research in the field of Embedded Systems, VLSI Systems and Communication Engineering.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE-641013

B.E.ELECTRONICS AND COMMUNICATION ENGINEERING

CBCS 2018 REGULATIONS

FIRST SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks
		Induction Programme	MC	0	0	0

Details of the Programme:

Number of Days: 21 Days

Day0: College Admission

Day1: Orientation Programme

Day2: Registration.

Day3 to Day 23 : Induction Programme

Activities:
Physical activity,
Playground Events,
Yoga Practices,
Literary, Proficiency modules,
Team Building,
Lectures by Eminent people,
Familiarization to department,
Branch oriented information,
Motivational speakers,
Talent exposure,
Quiz completion,
Visit to local areas….etc.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE-641013

B.E.ELECTRONICS AND COMMUNICATION ENGINEERING

CBCS 2018 REGULATIONS

FIRST SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LHS101	Communicative English	HS	50	50	100	2	1	0	3
2	18LBS102	Calculus and Differential Equations	BS	50	50	100	3	1	0	4
3	18LBS103	Waves , Optics and Introduction to Quantum Mechanics	BS	50	50	100	3	1	0	4
4	18LES104	Programming in C	ES	50	50	100	3	0	0	3
		PRACTICAL								
5	18LBS105	Physics Laboratory	BS	50	50	100	0	0	3	1.5
6	18LES106	Workshop Practice	ES	50	50	100	1	0	4	3
7	18LES107	Programming in C Laboratory	ES	50	50	100	0	0	3	1.5
		TOTAL		350	350	700	12	3	10	20

SECOND SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LBS201	Applied Chemistry	BS	50	50	100	3	1	0	4
2	18LBS202	Linear Algebra, Numerical Methods and Transform Calculus	BS	50	50	100	3	1	0	4
3	18LES203	Principles of Electrical Engineering	ES	50	50	100	3	0	0	3
		PRACTICAL								
4	18LBS204	Chemistry Laboratory	BS	50	50	100	0	0	3	1.5
5	18LES205	Principles of Electrical Engineering Laboratory	ES	50	50	100	0	0	3	1.5
6	18LES206	Engineering Graphics	ES	50	50	100	2	0	4	4
		TOTAL		300	300	600	11	2	10	18

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THIRD SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LBS301	Transforms and Partial Differential Equations	BS	50	50	100	3	0	0	3
2	18LES302	Data Structures and Algorithms	ES	50	50	100	3	0	2	4
3	18LPC303	Electron Devices and Circuits	PC	50	50	100	3	0	0	3
4	18LPC304	Digital System Design	PC	50	50	100	3	0	0	3
5	18LPC305	Signals and Systems	PC	50	50	100	3	0	0	3
6	18LPC306	Network Theory	PC	50	50	100	3	0	0	3
7	18LMC3Z7	Environmental Sciences and Engineering	MC	50	50	100	3	0	0	0
		PRACTICAL								
8	18LPC308	Electron Devices and Circuits Laboratory	PC	50	50	100	0	0	3	1.5
9	18LPC309	Digital Circuits Laboratory	PC	50	50	100	0	0	3	1.5
		TOTAL		**450**	**450**	**900**	**21**	**0**	**8**	**22**

FOURTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LBS401	Probability Theory and Random Processes	BS	50	50	100	3	0	0	3
2	18LES402	Electromagnetic Waves	ES	50	50	100	3	0	0	3
3	18LES403	Analog Circuits	ES	50	50	100	3	0	0	3
4	18LPC404	Analog Communication	PC	50	50	100	3	0	0	3
5	18LPC405	Microprocessors and Microcontrollers	PC	50	50	100	3	0	0	3
6	18LPC406	Analog Integrated Circuits	PC	50	50	100	3	0	0	3
7	18LMC4Z7	Constitution of India	MC	50	50	100	3	0	0	0
		PRACTICAL								
8	18LPC408	Analog Circuits and IC Laboratory	PC	50	50	100	0	0	3	1.5
9	18LPC409	Microprocessors and Microcontrollers Laboratory	PC	50	50	100	0	0	3	1.5
		TOTAL		**450**	**450**	**900**	**21**	**0**	**6**	**21**

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B.E.ELECTRONICS AND COMMUNICATION ENGINEERING

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FIFTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LHS501	Youth Empowerment for Yoga Practice	HS	50	50	100	3	0	0	3
2	18LPC502	Digital Communication	PC	50	50	100	3	0	0	3
3	18LPC503	Transmission lines and waveguides	PC	50	50	100	3	0	0	3
4	18LPC504	Digital Signal Processing	PC	50	50	100	3	0	0	3
5	18LPE5XX	Professional Elective – 1	PE	50	50	100	3	0	0	3
6	18LOE5XX	Open Elective -1	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18LPC507	Communication Engineering Laboratory	PC	50	50	100	0	0	3	2
8	18LPC508	Digital Signal Processing Laboratory	PC	50	50	100	0	0	3	1.5
		TOTAL		**400**	**400**	**800**	**18**	**0**	**6**	**21.5**

SIXTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LHS601	Professional Ethics	HS	50	50	100	3	0	0	3
2	18LPC602	VLSI Design	PC	50	50	100	3	0	0	3
3	18LPC603	Antennas and Wave Propagation	PC	50	50	100	3	0	0	3
4	18LPC604	Computer System Architecture and Organization	PC	50	50	100	3	0	0	3
5	18LPE6XX	Professional Elective – II	PE	50	50	100	3	0	0	3
6	18LOE6XX	Open Elective - II	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18LEE607	VLSI Design Laboratory	EEC	50	50	100	0	0	3	1.5
8	18LEE608	Embedded Systems Laboratory	EEC	50	50	100	0	0	3	1.5
		TOTAL		**400**	**400**	**800**	**18**	**0**	**6**	**21**

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SEVENTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LHS701	Management Theory and Practice	HS	50	50	100	3	0	0	3
2	18LPC702	Microwave Engineering	PC	50	50	100	3	0	0	3
3	18LPE7XX	Professional Elective – III	PE	50	50	100	3	0	0	3
4	18LPE7XX	Professional Elective – IV	PE	50	50	100	3	0	0	3
5	18LOE7XX	Open Elective –III	OE	50	50	100	3	0	0	3
6	18LOE7XX	Open Elective -IV	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18LPC707	Microwave and Antenna Laboratory	PC	50	50	100	0	0	3	1.5
8	18LEE708	Mini Project	EEC	50	50	100	0	0	8	4
9	18LVL709	Virtual Laboratory on Digital VLSI Design	EEC	50	50	100	0	0	2	1
		TOTAL		**400**	**400**	**800**	**18**	**0**	**13**	**24.5**

EIGHTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18LPE8XX	Professional Elective – V	PE	50	50	100	3	0	0	3
2	18LPE8XX	Professional Elective - VI	PE	50	50	100	3	0	0	3
		PRACTICAL								
3	18LEE803	Project Work	EEC	50	50	100	0	0	16	8
		TOTAL		**150**	**150**	**300**	**6**	**0**	**16**	**14**

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT (HS)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LHS101	Communicative English	HS	50	50	100	2	1	0	3
2	18LHS501	Youth Empowerment for Yoga Practice	HS	50	50	100	3	0	0	3
3	18LHS601	Professional Ethics	HS	50	50	100	3	0	0	3
4	18LHS701	Management Theory and Practice	HS	50	50	100	3	0	0	3

BASIC SCIENCES (BS)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LBS102	Calculus and Differential Equations	BS	50	50	100	3	1	0	4
2	18LBS103	Waves , Optics and Introduction to Quantum Mechanics	BS	50	50	100	3	1	0	4
3	18LBS105	Physics Laboratory	BS	50	50	100	0	0	3	1.5
4	18LBS201	Applied Chemistry	BS	50	50	100	3	1	0	4
5	18LBS202	Linear Algebra, Numerical Methods and Transform Calculus	BS	50	50	100	3	1	0	4
6	18LBS204	Chemistry Laboratory	BS	50	50	100	0	0	3	1.5
7	18LBS301	Transforms and Partial Differential Equations	BS	50	50	100	3	0	0	3
8	18LBS401	Probability Theory and Random Processes	BS	50	50	100	3	0	0	3

ENGINEERING SCIENCES (ES)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LES104	Programming in C	ES	50	50	100	3	0	0	3
2	18LES106	Workshop Practice	ES	50	50	100	1	0	4	3
3	18LES107	Programming in C Laboratory	ES	50	50	100	0	0	3	1.5
4	18LES203	Principles of Electrical Engineering	ES	50	50	100	3	0	0	3
5	18LES205	Principles of Electrical Engineering Laboratory	ES	50	50	100	0	0	3	1.5
6	18LES206	Engineering Graphics	ES	50	50	100	2	0	4	4
7	18LES302	Data Structures and Algorithms	ES	50	50	100	3	0	2	4
8	18LES402	Electromagnetic Waves	ES	50	50	100	3	0	0	3
9	18LES403	Analog Circuits	ES	50	50	100	3	0	0	3

PROFESSIONAL CORE (PC)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LPC303	Electron Devices and Circuits	PC	50	50	100	3	0	0	3
2	18LPC304	Digital System Design	PC	50	50	100	3	0	0	3
3	18LPC305	Signals and Systems	PC	50	50	100	3	0	0	3
4	18LPC306	Network Theory	PC	50	50	100	3	0	0	3
5	18LPC308	Electron Devices and Circuits Laboratory	PC	50	50	100	0	0	3	1.5
6	18LPC309	Digital Circuits Laboratory	PC	50	50	100	0	0	3	1.5
7	18LPC404	Analog Communication	PC	50	50	100	3	0	0	3
8	18LPC405	Microprocessors and Microcontrollers	PC	50	50	100	3	0	0	3
9	18LPC406	Analog Integrated Circuits	PC	50	50	100	3	0	0	3
10	18LPC408	Analog Circuits and IC Laboratory	PC	50	50	100	0	0	3	1.5
11	18LPC409	Microprocessors and Microcontrollers Laboratory	PC	50	50	100	0	0	3	1.5
12	18LPC502	Digital Communication	PC	50	50	100	3	0	0	3
13	18LPC503	Transmission lines and waveguides	PC	50	50	100	3	0	0	3
14	18LPC504	Digital Signal Processing	PC	50	50	100	3	0	0	3
15	18LPC507	Communication Engineering Laboratory	PC	50	50	100	0	0	3	1.5
16	18LPC508	Digital Signal Processing Laboratory	PC	50	50	100	0	0	3	1.5
17	18LPC602	VLSI Design	PC	50	50	100	3	0	0	3
18	18LPC603	Antennas and Wave Propagation	PC	50	50	100	3	0	0	3
19	18LPC604	Computer System Architecture and Organization	PC	50	50	100	3	0	0	3
20	18LPC702	Microwave Engineering	PC	50	50	100	3	0	0	3
21	18LPC707	Microwave and Antenna Laboratory	PC	50	50	100	0	0	3	1.5

PROFESSIONAL ELECTIVES (PE)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LPE$01	Information Theory and Coding	PE	50	50	100	3	0	0	3
2	18LPE$02	Speech Signal Processing	PE	50	50	100	3	0	0	3
3	18LPE$03	Introduction to MEMS	PE	50	50	100	3	0	0	3
4	18LPE$04	Power Electronics	PE	50	50	100	3	0	0	3
5	18LPE$05	Nano electronics	PE	50	50	100	3	0	0	3
6	18LPE$06	Soft computing	PE	50	50	100	3	0	0	3
7	18LPE$07	Automotive Electronics	PE	50	50	100	3	0	0	3
8	18LPE$08	Mixed Signal Design	PE	50	50	100	3	0	0	3
9	18LPE$09	Embedded systems	PE	50	50	100	3	0	0	3
10	18LPE$10	Data Communication Networks	PE	50	50	100	3	0	0	3
11	18LPE$11	Fiber Optic Communications	PE	50	50	100	3	0	0	3
12	18LPE$12	Advanced Digital Signal Processing	PE	50	50	100	3	0	0	3
13	18LPE$13	Low Power VLSI	PE	50	50	100	3	0	0	3
14	18LPE$14	Wireless Technologies	PE	50	50	100	3	0	0	3
15	18LPE$15	Digital Image and Video Processing	PE	50	50	100	3	0	0	3
16	18LPE$16	Control Systems	PE	50	50	100	3	0	0	3
17	18LPE$17	Adhoc and Wireless Sensor Networks	PE	50	50	100	3	0	0	3
18	18LPE$18	Satellite Communication	PE	50	50	100	3	0	0	3
19	18LPE$19	High Speed Electronics	PE	50	50	100	3	0	0	3
20	18LPE$20	Wavelet Transform	PE	50	50	100	3	0	0	3
21	18LPE$21	Error Correcting codes	PE	50	50	100	3	0	0	3
22	18LPE$22	Bio-Medical Electronics	PE	50	50	100	3	0	0	3
23	18LPE$23	Operation Research	PE	50	50	100	3	0	0	3
24	18LPE$24	Software Defined Radio	PE	50	50	100	3	0	0	3
25	18LPE$25	Internet of Things	PE	50	50	100	3	0	0	3
26	18LPE$26	Microwave Integrated Circuits	PE	50	50	100	3	0	0	3

OPEN ELECTIVES (O.E)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem. Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	18COE$01	Climate Change and Adaptation	OE	50	50	100	3	0	0	3
2.	18COE$02	Disaster Management and Mitigation	OE	50	50	100	3	0	0	3
3.	18COE$03	Energy Efficient Buildings	OE	50	50	100	3	0	0	3
4.	18MOE$04	Nanotechnology and Surface Engineering	OE	50	50	100	3	0	0	3
5.	18MOE$05	Mechatronics	OE	50	50	100	3	0	0	3
6.	18EOE$07	Renewable Power Generation Systems	OE	50	50	100	3	0	0	3
7.	18EOE$08	Electric Vehicles	OE	50	50	100	3	0	0	3
8.	18EOE$09	Smart Grid Systems	OE	50	50	100	3	0	0	3
9.	18LOE$10	Mobile Communication	OE	50	50	100	3	0	0	3
10.	18LOE$11	Introduction to VLSI System Design	OE	50	50	100	3	0	0	3
11.	18LOE$12	Microcontroller and Applications	OE	50	50	100	3	0	0	3
12.	18POE$13	Rapid Prototyping	OE	50	50	100	3	0	0	3
13.	18POE$14	Managerial Economics	OE	50	50	100	3	0	0	3
14.	18POE$15	Hydraulics and Pneumatics	OE	50	50	100	3	0	0	3
15.	18NOE$16	Measurement and Control	OE	50	50	100	3	0	0	3
16.	18NOE$17	Industrial Automation	OE	50	50	100	3	0	0	3
17.	18NOE$18	Virtual Instrumentation	OE	50	50	100	3	0	0	3
18.	18SOE$19	Programming in Java	OE	50	50	100	3	0	0	3
19.	18SOE$20	Cyber Security	OE	50	50	100	3	0	0	3
20.	18SOE$21	Network Essentials	OE	50	50	100	3	0	0	3
21.	18IOE$22	Programming in Python	OE	50	50	100	3	0	0	3
22.	18IOE$23	Big Data Science	OE	50	50	100	3	0	0	3
23.	18IOE$24	Object Oriented Programming Using C++	OE	50	50	100	3	0	0	3
24.	18BOE$25	Computational Biology	OE	50	50	100	3	0	0	3
25.	18BOE$26	Fundamental Concepts of Biology for Engineers	OE	50	50	100	3	0	0	3
26.	18BOE$27	Fundamentals of Bioengineering	OE	50	50	100	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC) – PRACTICAL COURSES AND PROJECT WORK

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LEE607	VLSI Design Laboratory	EEC	50	50	100	0	0	3	1.5
2	18LEE608	Embedded Systems Laboratory	EEC	50	50	100	0	0	3	1.5
3	18LEE708	Mini Project	EEC	50	50	100	0	0	8	4
4	18LEE803	Project Work	EEC	50	50	100	0	0	16	8
5	18LVL709	Virtual Laboratory on Digital VLSI Design	EEC	50	50	100	0	0	2	1

MANDATORY COURSE (MC) (NO - CREDIT)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LMC3Z7	Environmental Sciences and Engineering	MC	50	50	100	3	0	0	0
2	18LMC4Z7	Constitution of India	MC	50	50	100	3	0	0	0

VALUE ADDED COURSES (VA) (ONE CREDIT)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18LVA$01	Science of Creativity	VA	100	-	100	1	0	0	1
2	18LVA$02	Personal Leadership	VA	100	-	100	1	0	0	1
3	18LVA$03	Scripting Languages	VA	100	-	100	1	0	0	1
4	18LVA$04	Social Work	VA	100	-	100	1	0	0	1
5	18LVA$05	Android Application Development	VA	100	-	100	1	0	0	1
6	18LVA$06	Web Designing	VA	100	-	100	1	0	0	1
7	18LVA$07	Long Term Evolution	VA	100	-	100	1	0	0	1
8	18LVA$08	Avionics	VA	100	-	100	1	0	0	1
9	18LVA$09	Machine Vision	VA	100	-	100	1	0	0	1
10	18LVA$10	Millimeter Wave Communication	VA	100	-	100	1	0	0	1
11	18LVA$11	Telematics	VA	100	-	100	1	0	0	1
12	18LVA$12	E-Commerce Security	VA	100	-	100	1	0	0	1
13	18LVA$13	Simulation Techniques	VA	100	-	100	1	0	0	1
14	18LVA$14	Cloud Computing	VA	100	-	100	1	0	0	1
15	18LVA$15	Design of Power Supplies	VA	100	-	100	1	0	0	1
16	18LVA$16	Design of Communication Systems	VA	100	-	100	0	0	2	1
17	18LVA$17	Aptitude I	VA	100	-	100	1	0	0	1
18	18LVA$18	Aptitude II	VA	100	-	100	1	0	0	1
19	18LVA$19	Aptitude III	VA	100	-	100	1	0	0	1
20	18LVA$20	Micro strip antenna design	VA	100	-	100	1	0	0	1

CREDIT SUMMARY

Sl. No.	Subject Area	Credits per Semester								GCT Total Credits	% of Total Credits	AICTE Suggested Credits
		I	II	III	IV	V	VI	VII	VIII			
1	HS	3				3	3	3		12	7.4	12
2	BS	9.5	9.5	3	3					25	15.4	25
3	ES	7.5	8.5	4	6					26	16.0	24
4	PC			15	12	12.5	9	4.5		53	32.7	48
5	PE					3	3	6	6	18	11.1	18
6	OE					3	3	6		12	7.4	18
7	EEC						3	5	8	16	9.9	15
8	MC			0	0					0	0	0
	TOTAL	**20**	**18**	**22**	**21**	**21.5**	**21**	**24.5**	**14**	**162**	**100**	**160**

HS - Humanities and Social Sciences including Management

BS - Basic Science

ES - Engineering Science

PC - Professional Core

PE - Professional Elective

OE - Open Elective

EEC - Employment Enhancement Course

MC – Mandatory Course

18LHS101	COMMUNICATIVE ENGLISH *(Common to all Branches)*	SEMESTER I

PRE-REQUISITES: NIL **Category: HS**

L T P C
2 1 0 3

COURSE OBJECTIVES:

The course is intended to

- Make learners listen to audio files and replicate in speaking contexts
- Make learners read widely and practice it in writing
- Make learners develop vocabulary and strengthen grammatical understanding

UNIT-I : LISTENING	**(6+3 Periods)**
Listening Comprehension, Pronunciation, Intonation, Stress, Pause, Rhythm, Listening to Short & Long Conversations/Monologues - Note-Taking.	
UNIT-II : SPEAKING	**(6+3 Periods)**
Self Introduction, Making Oral & Formal Presentation, Communication at Work Place, Mock Interviews, Role Play Activities, Group Discussions, Debates, Delivering Welcome Address, Proposing Vote of Thanks, Introducing the Chief Guest at a function.	
UNIT-III : READING	**(6+3 Periods)**
Reading Comprehension, Speed Reading, Interpreting Visual Materials (Signs, Post Cards Pictures, Labels Etc.), Reading for Specific Information-Reading to identify Stylistic Features (Syntax, Lexis, Sentence Structures)-Cloze Test.	
UNIT-IV : WRITING	**(6+3 Periods)**
Phrase, Clause And Sentence Structures, Punctuation, Discourse Markers, Coherence, Precision in Writing, Graph & Process Description-Definition, Writing Email-Paraphrasing, Note making, Job Application With Resume, Writing Review of a Book / Movie, Creative Writing.	
UNIT-V : GRAMMAR AND VOCABULARY	**(6+3 Periods)**
Word Formation with Prefix and Suffix, Synonyms and Antonyms, Tenses, Parts of Speech, Common Errors in English (Subject –Verb Agreement, Noun-Pronoun Agreement, Prepositions, Articles, Conditional statements, Redundancies, Clichés etc), Voices.	

Contact periods:			
Lecture: 30 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. ***Board of Editors, Using English***, Orient Black Swan, 2015.

REFERENCE BOOKS:

1. ***Practical English Usage***, Michael Swan. OUP 1995.
2. ***Cambridge BEC Vantage*** - Practice Tests, Self-study Edition, CUP, 2002
3. ***Exercises in Spoken English***.Parts. I –III. EFLU, Hyderabad, OUP, 2014
4. ***Indlish***. Jyothi Sanyal, Viva Books,2006
5. ***Communicative English***. J.Anbazhagan Vijay, Global Publishers, Chennai. 2018

WEB REFERENCES

1. *www.cambridgeenglish.org/exams/business.../business-**preliminary**/*
2. *http://www.examenglish.com/BEC/BEC_Vantage.html*
3. *www.splendid-speaking.com/exams/**bec**_speaking.htmlhtml*

COURSE OUTCOMES:

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

CO1: Enhance their listening capacity through various accents and discourse

CO2: Communicate better at various public meeting and work place environments

CO3: Read and strengthen their interpretive and linguistic skills

CO4: Write appropriately on technical, business and general contexts.

CO5: Understand the usage of grammar and vocabulary

COURSE ARTICULATION MATRIX

PO / 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	PSO 1	PSO 2	PSO 3
CO1				M	H	L	M		H	H	M	H		M	
CO2				H	H	L	M	M	H	H	M	L			
CO3				H	H	L	M	M		H	M	H			L
CO4				H	H	L	M	M		H	M	L			L
CO5				L	H	L				H	M	H			
18LHS101				H	H	L	M	M	H	H	M	H		M	L

L – Low, M – Moderate (Medium), H- High

18LBS102	CALCULUS AND DIFFERENTIAL EQUATIONS *(Common to EEE, ECE & EIE Branches)*	SEMESTER I

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To be familiarize with differentiation of single variable and its applications.
- To obtain the knowledge of integration and its applications.
- To acquire knowledge of differentiation for more than one variable and vector differentiation.
- To gain the knowledge of multiple integration and related applications and vector integration including theorems.
- To gain methods to solve second order differential equations with constant and variable coefficients.

UNIT-I: Differential Calculus	**(9+3 Periods)**
Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima, Evolute of a curve.	
UNIT-II: Integral Calculus	**(9+3 Periods)**
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volume of revolution.	
UNIT-III: Multivariable Calculus (Differentiation)	**(9+3 Periods)**
Limit, continuity and partial derivatives, total derivative, Jacobians, Maxima, minima and saddle points, Method of Lagrange multipliers, Gradient, curl and divergence.	
UNIT-IV: Multivariable Calculus (Integration)	**(9+3 Periods)**
Multiple integration - Double integrals, change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Triple integrals (Cartesian), Change of variables (Cartesian to spherical polar). Theorems of Green, Gauss and Stokes, Simple applications involving cubes, sphere and rectangular parallelepipeds.	
UNIT-V : Ordinary differential equations of higher order	**(9+3 Periods)**
Second order linear differential equations with constant and variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation. Method of variation of parameters, Power series solutions of Bessel and Legendre equations.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Veerarajan T.,* ***Engineering Mathematics (for first year),*** *Tata McGraw-Hill , New Delhi,2008.*
2. *Srimanta Pal and suboth.C.Bhunia,* ***Engineering Mathematics****, Oxford university publications, New Delhi, 2015.*

REFERENCE BOOKS:

1. *B.S.Grewal,* ***Higher Engineering Mathematics****, Khanna Publishers, 43rd Edition,2015.*
2. *Erwinkreyszig,* ***Advanced Engineering Mathematics****, 9th Edition, John Wiley & Sons, 2006.*
3. *James Stewart,* ***Essential Calculus****, Cengage Learning, Delhi, 2nd Edition, 2013.*
4. *E. A. Coddington,* ***An Introduction to Ordinary Differential Equations****, Prentice Hall India, 1995.*
5. *G.F. Simmons and S.G. Krantz,* ***Differential Equations****, Tata McGraw Hill, 2007.*

COURSE OUTCOMES:

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

CO1: Understand the standard theorems and applications like maxima and minima, evolute of a curve using principles of differentiation.

CO2: Acquire fluency in integration of one variable for definite and improper integrals like beta and gamma functions and also applications of area and volumes.

CO3: Understand the techniques of partial differentiation and vector differentiation.

CO4: Understand multiple integration for finding area, surface and volume and applications to Green's, Stoke's and Gauss theorems under Vector Calculus.

CO5: Understand the general solutions to higher order differential equations and power series solutions to second order differential equations leading to Bessel and Legendre functions.

COURSE ARTICULATION MATRIX

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO2	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO3	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO4	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO5	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
18LBS102	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-

L – Low, M – Moderate (Medium), H- High

18LBS103	WAVES, OPTICS AND INTRODUCTION TO QUANTUM MECHANICS *(Common to EEE, ECE & EIE Branches)*	SEMESTER I

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

To improve the basic knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- Wave optics phenomenon, Huygens' principle, Interference of light.
- Basic principles in lasers, characteristics, types of lasers and its applications.
- Origin of quantum physics, Schrödinger's equation and its applications.
- Free electron theory, density of states in metals, Intrinsic and Extrinsic properties.
- Fiber optic principles and its applications.

UNIT-I : WAVE OPTICS	**(9+3 Periods)**
Huygens' Principle-superposition of waves and interference of light - Air wedge- Theory - Applications- Testing of flat surfaces –Thickness of a thin sheet of paper- Michelson interferometer-Theory-Applications-Determination of wavelength of monochromatic light.	
UNIT-II : LASER OPTICS	**(9+3 Periods)**
Einstein's theory of matter radiation interaction and A and B coefficients-amplification of light by population inversion-different types of lasers-gas laser-CO_2- solid state laser-Neodymium Nd-YAG laser-dye laser-properties of laser beams - monochromaticity-coherence-directionality and brightness-Applications of lasers in cutting , welding and materials processing.	
UNIT-III : INTRODUCTION TO QUANTUM MECHANICS	**(9+3 Periods)**
Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation- Properties of matter waves-de-Broglie wavelength in terms of voltage, energy, and temperature –Heisenberg's Uncertainty principle – verification – physical significance of a wave function- Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well .	
UNIT-IV : INTRODUCTION TO SOLIDS AND SEMICONDUCTORS	**(9+3 Periods)**
Quantum theory - Fermi distribution function - effect of temperature – density of energy states in metals-Semiconductors – Properties – elemental and compound semiconductors - Intrinsic and extrinsic semiconductors – properties - Carrier concentration in intrinsic Semiconductor - variation of Fermi level with temperature - extrinsic semiconductors - Carrier concentration in P- type and N-type semiconductors variation of Fermi level with temperature and impurity concentration.	
UNIT-V : FIBER OPTICS	**(9+3 Periods)**
Introduction – Basic Principles involved in fiber optics- Total internal reflection – Structure of optical fiber –Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change - Classification of optical fiber based on materials, refractive index profile and Modes - Fiber optical communication links-Fiber optic sensors- Temperature and displacement.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Arumugam M-* "***Engineering* Physics"**, *Anuradha Publishers, 2010. (Unit II, Unit III & Unit V)*
2. *P.K.Palanisamy-*"***Engineering physics-II"*** *Scitech publications (India) pvt. Ltd 2015 (Unit IV)*

REFERENCE BOOKS:

1. *Avadhanulu M N and Kshirsagar P G,* "***A Textbook of Engineering Physics***", *S.Chand and Company Ltd, New Delhi, 2010. (Unit I)*
2. *E.Hecht*, "***Optics"****, McGraw Hill Education, 2012.*
3. *D.J.Griffiths,* "***Quantum mechanics"****, Pearson Education, 2014*
4. *D.A.Neamen*, "***Semiconductor Physics and Device"s,*** *Times Mirror High Education Group, Chicago, 1997.*
5. *H.J.Pain,* "***The physics of vibrations and waves",*** *Wiley, 2006.*
6. *O.Svelto,* "***Principles of Lasers"****, Springer Science & Business Media, 2010.*

COURSE OUTCOMES:

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

CO1: Study the waves and optics phenomena- applications [Familiarity& Assessment]

CO2: Analyze the construction and working of gas lasers and solid state lasers. [Familiarity & Applications]

CO3: Analyze the dual nature of matter using de-Broglie matter waves, Heisenberg's Uncertainty principle, Schrodinger's time independent and dependent wave equations. [Familiarity & Application]

CO4: List and analyze the properties of conducting and Semiconducting materials and devices. [Familiarity & Application]

CO5: Explain fiber optics and classify fibers based on index profiles and modes [Familiarity & Application]

COURSE ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M	L		L							L	M		L
CO2	H	M	L		L							L	L		L
CO3	H	M	L		M							L	M	L	L
CO4	H	L	L									L	M		
CO5	H	M	H	M	M		L	L				L	M	M	M
18LBS103	H	M	H	M	M		L	L				L	M	M	M

L – Low, M – Moderate (Medium), H- High

18LES104	PROGRAMMING IN C *(Common to all Branches except MECH & PRODN Branches)*	SEMESTER I

Category: ES

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- The Computer and Programming fundamentals
- Data types in C and FLow control statements
- Functions, Arrays, Pointers And Strings
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input And Output

UNIT-I : COMPUTER AND PROGRAMMING FUNDAMENTALS	**(9 Periods)**
Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O – Introduction to software – Generation and classification of programming languages – Compiling – Linking and loading a program – Translator – loader – linker – develop a program – software development – Introduction to OS –Types of OS – Algorithms – Structured programming concept.	
UNIT-II : DATA TYPES AND FLOW OF CONTROL	**(9 Periods)**
An overview of C – Programming and Preparation – Program Output – Variables – Expressions, and Assignment, The use of #include, printf(), scanf() – Lexical elements, operators and the C systems – The fundamental data types – FLow of control.	
UNIT-III : FUNCTIONS, ARRAYS, POINTERS AND STRINGS	**(9 Periods)**
Functions and storage classes - 1D Arrays – Pointers – Call by reference – Relationship between Arrays and Pointers – Pointer arithmetic and element size – Arrays as function argument – Dynamic memory allocation – Strings – String handing functions – Multidimensional Arrays.	
UNIT-IV : ARRAY OF POINTERS, BITWISE OPERATORS, PREPROCESSOR DIRECTIVES	**(9 Periods)**
Arrays of Pointers – Arguments to main () - Ragged Arrays – Functions as Arguments – Arrays of Pointers to Functions - Type qualifiers.-Bitwise operators and expressions – Masks – Software tools – Packing and unpacking – Enumeration types – The preprocessor directives.	
UNIT-V : STRUCTURES AND UNIONS, I/O AND FILE OPERATIONS	**(9 Periods)**
Structures and Unions – Operator precedence and associativity – Bit fields – Accessing bits and bytes - Input and Output functions – File Processing Functions – Environment variables – Use of make and touch.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:0 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. *Pradip Dey, Manas Ghosh, "**Computer Fundamentals and Programming in C**", Second Edition, Oxford University Press, 2013.*
2. *Al Kelley, Ira Pohl, "A Book on C-Programming in C", Fourth Edition, Addison Wesley, 2001.*

REFERENCE BOOKS:

1. *Stephen G. Kochan, "**Programming in C-A complete introduction to the C programming language**", Third Edition, Sams Publication, 2004.*
2. *Yashavant P. Kanetkar, "**Let Us C**", 13th edition, BPB Publications, 2013.*
3. *Brian W. Kernighan and Dennis Ritchie, "**The C Programming Language**", Second Edition, Prentice Hall Software Series, 1988.*
4. *Stephen Prata, "**C Primer Plus**", Fifth Edition, Sams Publishing, 2005.*

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Articulate the programming environment [Familiarity].

CO2: Write algorithm for solving the given problem statement [Usage].

CO3: Use right data types and fLow control statements [Assessment].

CO4: Write programs using functions, arrays, pointers and strings [Usage].

CO5: Use right storage classes, preprocessor directives, bitwise operators in programs [Assessment].

CO6: Use structures, unions and files [Usage].

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	M	H	H		M	M	M	M	L	M	L	M	
CO2	H	H	M	H	H			M	M	M	L	M	L	M	
CO3	H	H	M	H	H			M	M	M	L	M	L		
CO4	H	H	M	H	H			M	M	M	L	M			
CO5	H	H	M	H	H			M	M	M	L	M	L		
CO6	H	H	M	H	H			M	M	M	L	M		L	
18LES104	H	H	M	H	H		M	M	M	M	L	M	H		

L-Low, M-Moderate (Medium), H-High

18LBS105	PHYSICS LABORATORY *(Common to all Branches)*	SEMESTER I

Category: BS

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
0	0	3	1.5

To improve the basic knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

* To have a practical knowledge about the concepts of physics and its applications in the emerging fields of engineering and technology

LABORATORY EXPERIMENTS			
1.	Spectrometer - Diffraction Grating Normal Incidence Method		
2	Air Wedge –Determination thickness of a paper		
3.	Young's Modulus – Cantilever Bending Koenig's Method		
4.	a) Laser - Particle size Determination b) Optical fiber - Determination of NA & Acceptance angle		
5.	Ammeter and Voltmeter Calibration – Low Range		
6.	Determination of Bandgap Energy of Semiconductor		
7.	Ultrasonic Interferometer - Velocity of sound & Compressibility of liquids.		
8.	Torsional pendulum –Determination of Rigidity Modulus & Moment of Inertia		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

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

CO1: Determine all physical properties of any matter.
CO2: Calibrate electrical measuring instruments and thereby effectively using it for particular application.
CO3: Understand principle of Laser diffraction and its application in particle size determination.
CO4: Understand the concept of light propagation through optical fibers and determination of its parameters.
CO5: Determine the Intrinsic characteristic features of electronic devices for electrical and electronic applications.
CO6: Understand the ultrasonic wave propagation in liquids and the determination of compressibility of liquids for engineering applications.

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M	L	L	L								M	L	L
CO2	H	M	L	L	L								M	M	L
CO3	H	M	L	L	L								M	M	L
CO4	H	M	L	L	L								M	M	L
CO5	H	M	L	L	L								M	M	L
CO6	H	M	L	M	L								M	M	L
18LBS105	H	M	L	M	L								M	M	L

L-Low, M-Moderate (Medium), H-High

18LES106	WORKSHOP PRACTICE *(Common to all Branches)*	SEMESTER I

Category: ES

PRE-REQUISITES: NIL

L	T	P	C
1	0	4	3

COURSE OBJECTIVES:

- To make various basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint, Dove tail joint, Mortise & Tenon joint and Cross-Lap joint.
- To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.
-

LIST OF EXPERIMENTS			
1	Introduction to use of tools and equipments in Carpentry, Welding, Foundry and Sheet metal		
2	Safety aspects in Welding, Carpentry and Foundry		
3	Half lap Joint and Dovetail Joint in Carpentry		
4	Welding of Lap joint, Butt joint and T-joint		
5	Preparation of Sand mould for cube, conical bush, pipes and V pulley		
6	Fabrication of parts like tray, frustum of cone and square box in sheet metal		
7	Electrical wiring – simple house wiring		
8	Plumbing		
9	CNC Machines demonstration and lecture on working principle.		
10	Additive manufacturing demonstration and lecture on working principle		
Contact periods:			
Lecture: 15 Periods	**Tutorial: 0 Periods**	**Practical: 60 Periods**	**Total: 75 Periods**

COURSE OUTCOMES:

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

CO 1: Safely Use tools and equipment's used in Carpentry, Welding, Foundry and Sheet metal to create basic joints.

CO 2: Prepare sand mold for various basic pattern shapes.

CO 3: Fabricate parts like tray, frustum of cone and square box in sheet metal.

CO 4: Carry out minor works/repair related to electrical wiring and plumbing.

CO 5: Demonstrate the working of CNC machines and additive manufacturing.

COURSE ARTICULATION MATRIX:

CO/ PO	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 O 1	PS O 2	PS O 3
CO1	H		L		L				L					L	
CO2	H		L		L				L					L	
CO3	H		L		L				L					L	
CO4	H		L		M				L					L	
CO5	H		L		H				L					L	
18LES106	H		L		M				L					L	

L-Low, M-Moderate (Medium), H-High

18LES107	**PROGRAMMING IN C LABORATORY** *(Common to all Branches except MECH & PRODN Branches)*	**SEMESTER I**

Category: ES

PRE-REQUISITES: NIL

L	**T**	**P**	**C**
0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Data types in C and FLow control statements
- Functions, Arrays, Pointers And Strings
- Dynamic memory allocation and command line arguments
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input and Output

PRACTICALS **EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:**	
1	Operators , Expressions and IO formatting
2	Decision Making and Looping
3	Arrays and Strings
4	Functions and Recursion
5	Pointers
6	Dynamic Memory Allocation
7	Structures
8	Unions
9	Files
10	Command line arguments
11	Mini Project

Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Use appropriate data types and fLow control statements [Usage]

CO2: Write programs using functions, arrays, pointers and strings [Usage]

CO3: Write programs using dynamic memory allocation [Usage]

CO4: Implement programs using right storage classes, preprocessor directives, bitwise operators [Usage]

CO5: Work with command line arguments, structures, unions and files [Usage]

CO6: Develop applications using C [Usage]

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	H	M	H	H			M	M	M	L	M	H	M	L
CO2	H	H	M	H	H			M	M	M	L	M	H	L	M
CO3	H	H	M	H	H			M	M	M	L	M	H	M	M
CO4	H	H	M	H	H			M	M	M	L	M	M	M	M
CO5	H	H	M	H	H			M	M	M	H	H	M	M	M
CO6	H	H	M	H	H			M	M	M	M	M	H	H	H
18LES107	H	H	M	H	H			M	M	M	M	M	H	H	M

L-Low, M-Moderate (Medium), H-High

18LBS201	APPLIED CHEMISTRY *(Common to EEE, ECE, EIE, CSE & IT Branches)*	SEMESTER II

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- The course is aimed at inculcating knowledge of applied chemistry topics which would be useful for students to understand Chemistry relevant to circuitry Engineering subjects.

UNIT-I : ELECTROCHEMICAL CELLS	**(9+3 Periods)**
Galvanic cells – redox reactions- electrodes - metal and metal ion, hydrogen electrode and calomel electrode – electrode potentials – standard oxidation and reduction potentials - Nernst equation and problems - EMF series and significance – Application of EMF measurements - pH measurement using glass electrode and fluoride measurement by ISE.	
UNIT-II : BATTERIES	**(9+3 Periods)**
Batteries - components, characteristics - voltage, current, current capacity, power density, energy density, cycle life, shelf life and self-discharge. Types of batteries- Primary - Zn/MnO_2, Zn/HgO, Zn/Ag_2O, $Li/SOCl_2$ - construction, function and performance comparison – Secondary- Pb/ acid, Ni/Cd, and Lithium ion battery- construction, function and performance comparison.	
UNIT-III : CORROSION	**(9+3 Periods)**
Corrosion- Spontaneity - Chemical corrosion- mechanism, nature of oxides – Pilliing Bedworth rule-electrochemical corrosion- mechanism-Galvanic series and importance – Prevention methods - design of materials, cathodic protection techniques(sacrificial anode and impressed current cathode), Inhibitors - Protective coatings-Inorganic coating- electroplating – surface preparation and plating method applied to Cr and Ni and galvanizing – Organic coating- paints - constituents and functions.	
UNIT-IV : SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	**(9+3 Periods)**
Beer Lambert's law -UV visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only)- Flame photometry- principle – instrumentation (block diagram only)- estimation of sodium by flame photometry- Atomic absorption spectroscopy – principles – instrumentation(block diagram only) – estimation of nickel by atomic absorption spectroscopy.	
UNIT-V : SILICON WAFER TECHNOLOGY	**(9+3 Periods)**
Silicon for IC chips - single crystal – preparation by Czechralsky and float zone processes- wafer preparation, P-N junction formation – Ion implantation , Diffusion and epitaxial growth techniques - Insulator layer by oxidation- Printing of circuits by photolithography – masking and electron beam methods- etching by chemical and electrochemical methods.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Jain. P.C. and Monica Jain,* ***"Engineering Chemistry",*** *Dhanpat Rai Publications Pvt. Ltd, New Delhi, 16th Edition, 2017.*
2. *Vairam. S, Subha Ramesh,* ***"Engineering Chemistry"****, Wiley India, 2015.*

REFERENCE BOOKS:

1. *Dara. S.S, Umarae*, "***Text book of Engineering Chemistry",*** *S. Chand Publications, 2013.*
2. *M.S.Tyagi,* ***"Introduction to semiconductor materials and devices",*** *Wiley India, 2012.*
3. *Y R Sharma ,* ***"Elementary Organic Spectroscopy",*** *S. Chand Publications, 2013.*
4. *B.R. Puri, L.R. Sharma & M. S. Pathania*, "***Principles of Physical Chemistry***", *S. Nagin Chand and Co., 2017*

COURSE OUTCOMES:

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

CO1: Understand the principles of electrochemical principles such as EMF measurements, electrode potentials and apply them in experimental techniques useful for electrochemical instrumentation.

CO2: Know the knowledge about different types of batteries with the functions which find use in their society including engineering fields.

CO3: Be familiar with corrosion of the instruments and equipment they use in their field and also to learn the mechanisms and the preventive measures by various techniques.

CO4: Know about the different types of spectroscopic techniques and applications.

CO5: Gain the knowledge about the silicon chips and their fabrication methods and to apply in preparation of in electrical and electronic instruments.

COURSE ARTICULATION MATRIX:

PO / 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	PSO 1	PSO 2	PSO 3
CO1	L	M		M	L										
CO2	M	L	L												
CO3	L	L	L	L		L	L							L	
CO4	L	H			L	L	L								
CO5	H	L												L	
18LBS201	L	L	L	M	L	L	L							L	

L-Low, M-Moderate (Medium), H-High

18LBS202	LINEAR ALGEBRA, NUMERICAL METHODS AND TRANSFORM CALCULUS *(Common to EEE, ECE, EIE & IBT Branches)*	SEMESTER II

Category: BS

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
3	1	0	4

- To know about matrix theory to solve linear system and diagonalise a matrix by orthogonal transformation.
- To be familiar with numerical solutions of equation with one variable and the knowledge of numerical interpolation, numerical differentiation and numerical integration.
- To acquire knowledge of numerical solution to first order ordinary differential equations using single and multi step techniques.
- To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.
- To be familiar with techniques of Laplace and Inverse Laplace transformation.

UNIT-I: Matrices	**(9+3 Periods)**
Inverse and rank of a matrix, System of linear equations, Eigenvalues and eigenvectors, Diagonalization of matrices, Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.	
UNIT-II: Interpolation, Numerical differentiation and integration	**(9+3 Periods)**
Solution of polynomial and transcendental equations: Newton-Raphson method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation and integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	
UNIT-III: Numerical solution of ordinary differential equations	**(9+3 Periods)**
Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods.	
UNIT-IV: Numerical solution of partial differential equations	**(9+3 Periods)**
Partial differential equations: Finite difference solution two dimensional Laplace equation and Poission equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.	
UNIT-V : Transform Calculus	**(9+3 Periods)**
Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ordinary differential equations by Laplace Transform method.	
Contact periods:	

Lecture: 45 Periods	**Tutorial: 15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *B.S.Grewal,* ***Higher Engineering Mathematics****, Khanna Publishers,New Delhi, 43rd Edition, 2015.*
2. *Srimanta Pal ,* ***Numerical Methods Principles, Analyses and Algorithms****, Oxford University Press, New Delhi, I st Edition 2009.*

REFERENCE BOOKS:

1. *Erwinkreyszig,* ***Advanced Engineering Mathematics****, 9th Edition, John Wiley & Sons, 2006.*
2. *N.P. Bali and Manish Goyal,* ***A text book of Engineering Mathematics****, Laxmi Publications, Reprint, 2008.*
3. *D.Poole,* ***Linear Algebra: A Modern Introduction****, 2nd Edition, Brooks/Cole, 2005.*
4. *P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***Numerical Methods****, S. Chand & Company, 3rd Edition, Reprint 2013.*
5. *S.S. Sastry,* ***Introductory methods of numerical analysis****, PHI, New Delhi, 5th Edition, 2015.*
6. *Ward Cheney, David Kincaid,* ***Numerical Methods and Computing,*** *Cengage Learning, Delhi, 7th Edition 2013.*

COURSE OUTCOMES:

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

CO1: Solve the linear system of equations by rank of a matrix and matrix inversion and understand the process of diagonalisation by orthogonal transformation.

CO2: Acquire fluency in numerical solution to equation by Newton Raphson method, numerical interpolation techniques with equal and unequal intervals, numerical differentiation and integration.

CO3: Understand numerical solution to first order ordinary differential equations by single step and multistep methods.

CO4: Understand numerical solution to second order partial differential equations using finite differences.

CO5: Understand how to find Laplace and Inverse Laplace transforms with applications.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO2	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO3	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO4	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
CO5	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-
18LBS202	H	L	L	-	-	-	-	-	-	-	-	M	L	-	-

L – Low, M – Moderate (Medium), H- High

18LES203	PRINCIPLES OF ELECTRICAL ENGINEERING	SEMESTER II

Category: ES

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To understand the basic concepts of electric circuits, measurements techniques and instruments.
- To study the working principles of DC and AC machines.
- To introduce the components of Electrical installations and energy conservation.

UNIT-I : DC CIRCUITS	**(9 Periods)**
Electrical circuit elements (R,L and C) - Voltage and current sources – Ohm's Law – Kirchoff laws –R, RL, RC, RLC circuits with DC excitation - Time domain analysis of First order RL, RC circuits and RLC circuits.	
UNIT-II : AC CIRCUITS	**(9 Periods)**
Representation of sinusoidal waveforms – Average, RMS and Peak values – Form factor and Peak factor - Phasor representation – Real, Reactive, Apparent power and power factor – Analysis of single phase AC circuits consisting of R,L,C, RL, RC, RLC combinations – Resonance - Three phase balanced circuits – Voltage and current relations in star – delta connections.	
UNIT-III : ELECTRICAL MACHINES	**(9 Periods)**
DC machines: Construction, Principle of operation, basic equations and Types, Characteristics and Applications of DC generators, DC motors. AC machines : Single phase Transformer – Equivalent circuit, losses, Regulation and efficiency - Auto transformer - Construction, Principle of operation, basic equations and Types, Characteristics and Applications of Single phase and Three phase Induction motor – Synchronous Motor – Alternator	
UNIT-IV: ELECTRICAL AND ELECTRONIC INSTRUMENTS	**(9 Periods)**
Functional elements of an instrument – Static and Dynamic Characteristics – Errors in measurements - Types of instruments - Operating principles of Moving coil, Moving iron Instruments (Ammeter and Voltmeters), Dynamometer type watt meters and Induction type Energy meters – Standards and Calibrations – Cathode Ray Oscilloscope – Digital Storage Oscilloscope.	
UNIT-V : ELECTRICAL INSTALLATIONS AND ENERGY CONSERVATION	**(9 Periods)**
Single phase and three phase system – phase, neutral and earth, basic house wring -tools and components, different types of wiring - basic safety measures at home and industry – Energy efficient lamps - Energy billing. Components of LT switchgear : Switch fuse unit, MCB, ELCB, MCCB, Types of wires and Cables – Earthing Batteries – Principle, characteristics, types and applications.	

Contact periods:			
Lecture: 45 Periods	**Tutorial: 0 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. *Mittle V.N and Aravind Mittal*, **"*Basic Electrical Engineering*",** *Tata McGraw Hill, Second Edition, New Delhi, 2005.*
2. *D.P.Kothari, I.J. Nagrath, " Basic Electrical Engineering", Tata McGraw Hill, 2010.*
3. *A. K. Sawhney*, "***A Course in Electrical & Electronic Measurements & Instrumentation"***, Dhanpat Rai and Co, 2004.

REFERENCE BOOKS:

1. *Nagsarkar T.K and Sukhija M.S, "**Basic Electrical Engineering**", Oxford Press, 2005.*
2. *E.Hughes,"**Electrical and Elecronics Technology**", Pearson, 2010*
3. *Mohmood Nahvi and Joseph A.Edminister, "**Electric Circuits**", Shaum Outline series, McGraw Hill, Sixth edition, 2014*
4. *Premkumar N and Gnanavadivel J, "**Basic Electrical and Electronics Engineering**", Anuradha Publishers, 4th Edition, 2008.*

COURSE OUTCOMES:

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

CO1: Analyze the DC and AC Circuits.
CO2: Explore the significance of Electrical machines.
CO3: Acquire the knowledge on Measurement techniques and Instruments.
CO4: Utilize the components of electrical installations.
CO5: Assembly of electrical wiring.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	-	L	-	-	-	-	-	-	L	M	-
CO2	M	M	H	H	-	M	-	-	-	-	-	-	M	L	L
CO3	M	H	M	L	-	M	-	-	-	-	-	-	M	L	L
CO4	H	M	L	L	H	M	L	-	L	M	-	-	L	L	M
CO5	M	L	H	M	L		L	M-	-	-	-	-	L	L	-
18LES203	M	H	M	M	L	M	L	L	-	L	-	-	L	L	L

L-Low. M-Moderate, H-High

18LBS204	CHEMISTRY LABORATORY *(Common to all Branches)*	SEMESTER II

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To inculcate the practical applications of chemistry to students and make them apply in the fields of engineering and technology

LIST OF EXPERIMENTS			
1.	Estimation of hardness by EDTA method.		
2	Estimation of chloride by Argentometric method.		
3.	Conductometric titration of mixture of strong acid and weak acid using strong base.		
4.	Potentiometric titration of ferrous iron by dichromate.		
5.	Determination of Saponification value of an oil.		
6.	Estimation of Iron by Spectrophotometry.		
7.	Estimation of HCl by pH titration.		
8.	Determination of the rate constant of reaction.		
9.	Estimation of Dissolved Oxygen.		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

REFERENCE BOOKS:

1. *A.O. Thomas, "**Practical Chemistry"**, Scientific Book Centre, Cannanore, 2003.*
2. *Vogel's "**Text book of Quantitative Analysis"**, Jeffery G H, Basset J. Menthom J, Denney R.C., 6th Edition, EBS, 2009.*

COURSE OUTCOMES:

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

CO1: Understand the nature of hardness using EDTA Complex

CO2 Iron present in water can be estimated and chloride level, pollution level using dissolved oxygen content.

CO3: Apply the EMF and conductometric measurements in quantitative analysis of Substances.

CO4: pH of the liquid sample will be analysed and hence strength of the sample can be estimated using pH Meter

COURSE ARTICULATION MATRIX:

PO / 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	PSO 1	PSO 2	PSO 3
CO1	L	L	L			L									
CO2	L											L			
CO3	M	L		L	L									L	
CO4	M	M		L	L										
18LBS204	M	L	L	L	L							L		L	

L-Low, M-Moderate (Medium), H-High

18LES205	PRINCIPLES OF ELECTRICAL ENGINEERING LABORATORY	SEMESTER II

Category: ES

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
0	0	3	1.5

- To understand the performance characteristics of DC and AC machines
- To calibrate and Measuring capability of the DC and AC meters
- To impart practical knowledge on Wiring

LIST OF EXPERIMENTS			
1.	Verification of Ohm's law and Kirchoff's law		
2	Measurement of three phase power by two wattmeter method		
3.	Measurement of three phase power by three voltmeter, three ammeter method		
4.	Calibrations of Ammeter, Voltmeter, Wattmeter and Single phase Energy meter		
5.	Measurements of voltage, current, power on primary and secondary side of single phase and three phase transformers		
6.	Measurement of AC signal parameters using CRO/DSO and Function generators		
7.	Demonstration of cut out sections of DC and AC machines.		
8.	Open circuit characteristics and load test on d.c. shunt generator.		
9.	Speed control of d.c. shunt motor.		
10.	Load test on single phase transformer.		
11.	Study of components of LT Switchgear		
12.	Fluorescent lamp wiring, Stair case wiring and Residential house wiring using fuse, indicator, lamp and energy meter.		
13.	Study of battery characteristics during charging and discharging.		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

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

CO1: Verify Ohm's law Kirchoff's law on electrical circuits.

CO2: Performance characteristics of DC machines and transformers.

CO3: Perform Measurements DC and AC Instruments

CO4: Able to do domestic and industrial wiring

CO5: Studying the characteristics of battery charging and discharging.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	-	L	-	-	-	-	-	-	L	L	-
CO2	M	M	H	H	-	M	-	-	-	-	-	-	M	L	L
CO3	M	M	H	H	-	L	-	-	-	-	-	-	L	M	-
CO4	M	H	M	L	L	L	-	-	-	-	-	-	M	L	L
CO5	M	M	H	H	-	-	-	-	-	-	M	M	-	-	-
18LES 205	M	M	H	H	-	L	-	-	-	-	L	L	L	L	L

L-Low. M-Moderate, H-High

18LES206	ENGINEERING GRAPHICS *(Common to All Branches)*	SEMESTER II

Category: ES

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
2	0	4	4

- Geometrical constructions
- Orthographic projections.
- Performing section of solids and development of the same.
- Pictorial view of solids
- Familiarization of CAD packages.

UNIT-I : GEOMETRICAL CONSTRUCTIONS	**(6+12 Periods)**
Dimensioning-Lettering-Types of Lines-Scaling conventions-Dividing a given straight line in to any number of equal parts- Bisecting a given angle- Drawing a regular polygon given one side-Special methods of constructing a pentagon and hexagon.	
UNIT-II : ORTHOGRAPHIC PROJECTIONS	**(6+12 Periods)**
Introduction to Orthographic Projection-Projection of points-Projection of straight lines with traces - Conversion of pictorial views to orthographic views-Projection of solids	
UNIT-III : SECTION OF SOLIDS AND DEVELOPMENT	**(6+12 Periods)**
Section of solids- Development of surfaces	
UNIT-IV : PICTORIAL VIEWS	**(6+12 Periods)**
Isometric projections - Conversion of orthographic views to pictorial views (simple objects).	
UNIT-V : COMPUTER AIDED DRAFTING	**(6+12 Periods)**
Introduction to computer aided drafting package to make 2-D Drawings. OBJECT CONSTRUCTION – page layout – Layers and Line type – Creating, Editing and selecting the Geometric Objects MECHANICS – Viewing, Annotating, Hatching and Dimensioning the drawing – Creating Blocks and Attributes, DRAFTING – Create 2D drawing. A number of chosen problems will be solved to illustrate the concepts clearly. (Demonstration purpose only, not be included in examinations)	
Contact periods:	

Lecture: 30 Periods	**Tutorial: 0 Periods**	**Practical: 60 Periods**	**Total: 90 Periods**

TEXT BOOKS:

1. *K.Venugopal, **"Engineering Graphics"**, New Age International (P) Limited, 2015.*
2. *K.L.Narayana and P.Kannaiah, **"Text book on Engineering Drawing,"** 2nd Edition, SciTech Publications (India) Pvt. Ltd, Chennai, 2009.*

REFERENCE BOOKS:

1. *Dhananjay.A.Jolhe, **"Engineering Drawing"**, Tata McGraw Hill Publishing Co., 2007.*
2. *K.V.Nataraajan, **"A text book of Engineering Graphics"**, Dhanalakashmi Publishers, Chennai, 2006.*
3. *M.B.Shah and B.C. Rana, **"Engineering Drawing"**, Pearson Education, 2005.*
4. *Luzadder and Duff, **"Fundamentals of Engineering Drawing"**, Prentice Hall of India Pvt Ltd, XIth Edition, 2001.*
5. *Alan Kalameja, "**AutoCAD 2008: A tutor for Engineering Graphics",** Auto Desk Press 2007*
6. *CAD Software manuals of latest version.*

COURSE OUTCOMES:

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

CO1: Construct basic geometric shapes and dimension the drawing as per standards.

CO2: Project points, lines and solids in various positions, and convert 2D projections to pictorial projections.

CO3: Generate sectional views of solids and construct development drawings.

CO4: Generate and interrupt pictorial views.

CO5: Use AutoCAD to create simple Engineering Drawings.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			L		M	L			M	M	L			M	
CO2			L		M	L			M	M	L			M	
CO3			L		H	L			M	M	L			M	
CO4			L		H	L			M	M	L			M	
CO5			L		H	L			M	M	L			M	
18LES206			L		H	L			M	M	L			M	

L-Low. M-Moderate, H-High

18LBS301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	SEMESTER III

Category: BS

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To gain the knowledge of Fourier series.
- To be familiar with forming and solving partial differential equations.
- To acquire knowledge of techniques to solve one and two dimensional partial differential equations concerning to engineering applications.
- To be familiar with concept and applications of Fourier and Z transforms.

UNIT I: FOURIER SERIES	**(9 Periods)**
Dirichlet's Conditions – General Fourier series – Odd and even functions- Half range Sine and Cosine series – Parseval's Identity on Fourier series–Harmonic Analysis.	
UNIT II: PARTIAL DIFFERENTIAL EQUATIONS	**(9 Periods)**
Formation of partial differential equations – First order partial differential equations – Standard types and Lagrange's type – Linear partial differential second and higher order with constant coefficients – Homogeneous types.	
UNIT III: BOUNDARY VALUE PROBLEMS	**(9 Periods)**
Classification of partial differential equations – Method of separation of variables –One dimensional wave equation – One dimensional heat equation – Transient and Steady state conditions – Fourier series solution.	
UNIT IV: FOURIER TRANSFORMS	**(9 Periods)**
Statement of Fourier integral Theorem – Fourier transform pair – Fourier Sine and Cosine Transforms–Properties – Transforms of Simple Functions – Convolution Theorem – Parseval's Identity-Finite Fourier transforms.	
UNIT V: Z TRANSFORMS	**(9 Periods)**
Z-transforms - Elementary Properties-Inverse Z-transforms - Initial and Final value theorems - Convolution theorem –Formation of difference equations-Solution to difference equations of second order with constant coefficients using Z- transform.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXTBOOKS:

*1. Veerarajan.T., **"Transforms and partial Differential equations"**, Tata McGraw Hill Publishing Co., NewDelhi.2015.*

REFERENCE BOOKS:

*1. B.S.Grewal., "**Higher Engineering Mathematics**", Khanna Publishers, New Delhi,44rd Edition, 2018*

*2. Kandasamy, Thilagavathy and Gunavathy., "**Engineering Mathematics**" for III Semester, S.Chand&Co, Ramnagar, New Delhi.*

*3. N.P.Bali and Manish Goyal., "**Transforms and partial Differential equations**", University Science Press, New Delhi, 2010.*

*4. Erwinkreyszig, "**Advanced Engineering Mathematics**", 9th Edition, John Wiley & Sons, 2006.*

*5.Ray Wylie C and Louis C Barrett, "**Advanced Engineering Mathematics**", McGraw Hill Education (India) Pvt Ltd., New Delhi, 6thEdition 2014.*

COURSE OUTCOMES:

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

CO1: Understand the concepts of Fourier series and its construction when discrete and continuous form is known.

CO2: Understand the standard and special types of partial differential equations.

CO3: Solve boundary value problems.

CO4: Apply Fourier transforms in order to solve improper integrals.

CO5: Utilize the Z transform methods to find solutions of difference equations.

COURSE ARTICULATION MATRIX

PO / 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	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M	H	H	M	L	L	M	M	M	L	L
CO2	H	H	H	M	M	H	M	L	L	L	L	M	M	L	M
CO3	H	H	H	M	L	M	L	L	M	M	L	M	M	L	M
CO4	H	H	H	M	M	M	L	L	M	M	L	M	M	M	M
CO5	H	H	H	H	L	M	M	M	L	L	M	M	M	M	L
18LBS 301	H	H	H	H	M	H	H	M	M	M	M	M	M	M	M

L - Low, M - Moderate (Medium), H - High

18LES302	DATA STRUCTURES AND ALGORITHMS	SEMESTER III

Category: ES

PRE-REQUISITES: NIL

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

- To understand the concepts of ADTs
- To Learn linear data structures – lists, stacks, and queues
- To understand sorting, searching and hashing algorithms
- To apply Tree and Graph structures

UNIT-I: LINEAR DATA STRUCTURES – LIST	**(9 Periods)**
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 Periods)**
Stack ADT – Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix to postfix expression - Queue ADT – Operations - Circular Queue – Priority Queue - dequeue – applications of queues.	
UNIT-III: NON LINEAR DATA STRUCTURES – TREES	**(9 Periods)**
Tree ADT – tree traversals - Binary Tree ADT – expression trees – applications of trees – binary search tree ADT –Threaded Binary Trees- AVL Trees – B-Tree - B+ Tree - Heap – Applications of heap.	
UNIT-IV: NON-LINEAR DATA STRUCTURES – GRAPHS	**(9 Periods)**
Definition – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits – Applications of graphs.	
UNIT-V: SEARCHING, SORTING AND HASHING TECHNIQUES	**(9 Periods)**
Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort - Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 30 Periods** **Total: 75 Periods**

TEXT BOOKS:

1. *Mark Allen Weiss, — "**Data Structures and Algorithm Analysis in C**", 2nd Edition, Pearson Education, 2002.*
2. *Reema Thareja, — "**Data Structures Using C**", Second Edition, Oxford University Press, 2011*

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, Sartaj Sahni, Susan Anderson-Freed, — **"Fundamentals of Data Structures in C**", Second Edition, University Press, 2008*

COURSE OUTCOMES:

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

CO 1: Implement abstract data types for linear data structures.

CO 2: Apply the different linear and non-linear data structures to problem solutions.

CO 3: Critically analyze the various sorting algorithms.

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	-	-	-	-	-	-	-	M	L	-	L	H	L	L
CO2	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L
CO3	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L
18LES 302	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPC303	ELECTRON DEVICES AND CIRCUITS	SEMESTER III

PRE-REQUISITES: 18LBS103 WAVES, OPTICS AND INTRODUCTION TO QUANTUM MECHANICS **Category: PC**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To have knowledge on Semiconductor device manufacturing technology
- To familiarize the operation, biasing methods and applications of semiconductor devices
- To understand the operation of special purpose semiconductor devices

UNIT- I: SEMICONDUCTOR TECHNOLOGY	**(9 Periods)**
Crystal Growth and Epitaxy: Silicon crystal growth from the melt - Silicon float zone process - GaAs Crystal growth techniques - Material characterization - Epitaxial growth techniques - Film formation: Thermal oxidation - Chemical vapor deposition of Polysilicon - Atomic layer deposition – Metallization - Lithography And Etching: Optical lithography - Wet chemical etching - Dry etching - Impurity doping: Basic diffusion process - Extrinsic diffusion - Range of implanted ions - Implant damage and annealing -PN Junction diode- I-V characteristics -Breakdown mechanism - Diode Equivalent Circuits – Transition and Diffusion Capacitance – Reverse Recovery Time -Small Signal model of Diode– Zener diode- Operation in the Reverse breakdown region.	
UNIT- II: BJT THEORY AND BIASING	**(9 Periods)**
Simplified Structure and Modes of Operation - Operation of NPN Transistor in the Active mode - Ebers-moll Model - PNP transistor - Current Voltage characteristics -Early effect – CE, CB and CC Characteristics - DC load line - Operating Point - Fixed Bias - Emitter Bias - Voltage Divider Bias Circuits - Comparison of Basic Bias circuits - Bias circuit Design - Bias Stabilization –IGBT.	
UNIT- III: FET THEORY AND BIASING	**(9 Periods)**
JFET Device Structure and Operation-Transfer Characteristics – CS, CG and CD Configurations - P-Channel MOSFET-N-Channel MOSFET –Ideal I-V Characteristics – Non ideal I-V effects-Depletion Type MOSFET - Enhancement Type MOSFET - FET DC load line and Biasing point - Gate Bias, Self Bias, Voltage Divider Bias Configurations - Comparison of Basic Bias circuits - Bias Circuit Design.	
UNIT- IV: SPECIAL PURPOSE SEMICONDUCTOR DEVICES	**(9 Periods)**
UJT- Varactor Diode - Photodiodes –Phototransistors - IR Emitters – Solar Cells - Silicon Controlled Rectifier – SCR as Silicon Controlled Switch – SCR as Gate Turn-off Switch – Power diode – TRIAC - Power Transistor – Operation of LCD, Plasma, LED and HDTV .	
UNIT- V: APPLICATIONS OF SEMICONDUCTOR DEVICES	**(9 Periods)**
Applications of Diode: Rectifier Circuits - Bridge Rectifier with Capacitor, Inductor Filters - L and π Section Filters - Clippers - Clampers - Voltage Doubler - Zener Diode as Shunt Voltage Regulator..Applications of BJT: Relay driver – Transistor switch –SMPS - UJT Relaxation oscillator. Applications of FET: Voltage controlled resistor – FET in Fiber Optic system –UPS.	

Contact Periods:

Lecture: 45 Periods Tutorial: 0Periods Practical: 0Periods Total:45 Periods

TEXT BOOKS:

1. *S.M.Sze, M.K. Lee, "**Semiconductors Devices Physics and Technology"**, John Wiley & Sons Inc., 3rd Edition, 2012*
2. *Robert Boylestead and Louis Nashelsky, "**Electron Devices and Circuits Theory**", Prentice Hall of India, 11th Edition, 2015.*
3. *D. Neamen , D. Biswas "**Semiconductor Physics and Devices**", McGraw-Hill Education, 4th Edition, 2012.*

REFERENCE BOOKS:

1. *Sedra and Smith, **"Microelectronic Circuits"**, Oxford University Press, 5th Edition, 2009.*
2. *S.Salivahanan, N.Suresh Kumar and A. Vallavaraj. **"Electronic Devices and Circuits"**, 2nd edition TMH, 2010.*
3. *Thomas.L.Floyd, **"Electronic Devices: Conventional Current version"**, Pearson, 9th Edition, 2015.*
4. *Millman and Halkias.C., **"Integrated Electronics"**, Tata McGraw Hill, 1st Edition, 2008.*
5. *Jimmie J Cathey., **"Schaum's Outlines - Electronic Devices and Circuits"**, McGraw Hill, 2nd Edition, 2011.*

COURSE OUTCOMES:

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

CO 1: Describe the process in semiconductor technology and the characteristics, applications of semiconductor diodes

CO 2: Discuss the characteristics and design biasing circuits of BJT & FET

CO 3: Explain the characteristics and applications of Special purpose semiconductor devices

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	L	L	-	-	-	-	-	-	-	-	-	H	M	-
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	-
CO3	H	L	L	-	-	-	-	-	-	-	-	-	H	M	-
18LPC 303	H	M	L	-	-	-	-	-	-	-	-	-	H	M	-

L - Low, M - Moderate (Medium), H – High

18LPC304	DIGITAL SYSTEM DESIGN	SEMESTER III

Category: PC

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To acquire knowledge on digital logic design and apply knowledge to understand and design digital electronics circuits

UNIT I: BINARY CODES AND BOOLEAN ALGEBRA	**(9 Periods)**
Binary, BCD, Grey Codes - ASCII and Error Detecting Codes - Boolean Algebra - Boolean functions - Canonical and Standard Forms - Minimization of Boolean expressions - Karnaugh map minimization - Don't care conditions - Tabulation Method - Implementation of logic functions using Gates - NAND and NOR implementation- Variable entered k- map.	
UNIT II: COMBINATIONAL LOGIC CIRCUITS	**(9 Periods)**
Binary Adder - Binary Subtractor - BCD Adder - Binary Multiplier - Magnitude Comparator - Multiplexer/Demultiplexer - Decoder/Encoder - Code converters - Implementation of combinational logic using MUX/Decoder - Introduction to Verilog HDL - Verilog code for Full Adder, MUX/DeMUX and Code Converters.	
UNIT III: SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS	**(9 Periods)**
Latches - Flip flops - Analysis and Design of Clocked Sequential Circuits – State Reduction and State Assignment - Ripple Counters: Binary, BCD, Modulo n, Up/Down counters - Shift registers: - Universal Shift Register–Synchronous counters - Ring counter – Johnson counter - Verilog code for Flip Flops, Registers and Counters.	
UNIT IV: ASYNCHRONOUS SEQUENTIAL CIRCUITS	**(9 Periods)**
Block Diagram - Modes of Operation – Analysis of Asynchronous Sequential Circuits - Design of Asynchronous Sequential Circuits - Reduction of FLow Tables - Races – Hazards- Clock skews.	
UNIT V: MEMORY AND PROGRAMMING LOGIC	**(9 Periods)**
Classification of Memories - RAM organization - Memory decoding - Memory expansion - Static RAM cell - Dynamic RAM cell - ROM organization - Types of ROM - Programmable Logic Array -Programmable Array Logic - Field Programmable Gate Arrays- Flash cache.	

Contact Periods:
Lecture: 45 periods Tutorial: 0 periods Practical: 0 periods Total: 45 periods

TEXT BOOKS:

*1. M. Morris R. Mano and Michael D. Ciletti, "**Digital Design**" 4th Edition, Pearson Education, 2011.*

*2. M. Morris R. Mano and Michael D. Ciletti, "**Digital Design: With an Introduction to the Verilog HDL**",5th Edition, Pearson Education, 2013.*

REFERENCE BOOKS:

*1. Stephen Brown, ZvonkoVranesic, **"Fundamentals of Digital Logic with Verilog Design"**, 2nd Edition, Tata McGraw Hill Education Pvt.Ltd., 2010.*
*2. A.Anand Kumar, **"Fundamentals of Digital Circuits"**, 2nd Edition, PHI Learning Pvt.Ltd, New Delhi,2011.*
*3. Charles H.Roth, Jr, **"Fundamentals of Logic Design"**, 4th Edition, Jaico Publishing House, 2006.*
*4. Donald D.Givone, **"Digital Principles and Design"**, Tata Mc-Graw-Hill Publishing Company Ltd., 2003.*
*5. Samir Palnitkar, **"Verilog HDL"**, Pearson Education, 2009.*

COURSE OUTCOMES:

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

CO1: In-depth knowledge on Binary Codes and Boolean algebra

CO2: Ability to realize combinational and sequential logic circuits using Verilog HDL design

CO3: Ability to design and analyze Synchronous and Asynchronous digital circuits

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	-	H	L	-	-	-	-	-	-	-	L	-	-
CO2	L	M	-	H	L	M	-	-	-	-	-	-	-	H	-
CO3	M	M	-	M	L	-	-	-	-	-	-	-	-	-	-
18LPC 304	L	M	-	H	L	M	-	-	-	-	-	-	L	H	-

L - Low, M - Moderate (Medium), H - High

18LPC305	SIGNALS AND SYSTEMS	SEMESTER III

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Category: PC

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To analyze the Continuous Time and Discrete Time signals and systems
* To gain knowledge of Fourier and Laplace Transforms and its application in the analysis of Continuous Time Systems
* To gain knowledge of Discrete Time Fourier Transforms and Z-Transforms and its application in the analysis of Discrete Time Systems
* To analyze state variable equations of linear time invariant Continuous and Discrete Time Systems and its matrix representation

UNIT I: INTRODUCTION TO SIGNALS AND SYSTEMS	**(9 Periods)**
Introduction to Continuous Time (CT) signals and Discrete Time (DT) signals - step, ramp, impulse, exponential, sinusoidal signals, Representation of DT signals by impulses- signal operations- classification of CT and DT signals –periodic and aperiodic signals, random signals, energy and power signals, even and odd signals- linear time invariant CT systems and DT systems- basic system properties: linear time invariant, causality, BIBO stability	
UNIT II: ANALYSIS OF CONTINUOUS TIME SIGNALS	**(9 Periods)**
Fourier series analysis- spectrum of Continuous Time signals- properties of continuous time Fourier series, Fourier transform of continuous time aperiodic signals and periodic signals, properties of continuous time Fourier transform. Fourier and Laplace Transforms in signal Analysis	
UNIT III: LINEAR TIME INVARIANT–CONTINUOUS TIME SYSTEMS	**(9 Periods)**
Differential Equation- CT system representations by differential equations -Block diagram representation-impulse response, convolution integrals- Frequency response of systems characterized by Differential Equations- Fourier and Laplace transforms in Analysis.	
UNIT IV: ANALYSIS OF DISCRETE TIME SIGNALS	**(9 Periods)**
Baseband Sampling of CT signals- Aliasing, Reconstruction of CT signal from DT signal, Discrete Time Fourier series representation of DT periodic signals – Properties – Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – Properties – Z Transforms- properties.	
UNIT V: LINEAR TIME INVARIANT –DISCRETE TIME SYSTEMS	**(9 Periods)**
Difference Equations-Block diagram representation-Impulse Response-Convolution sum -DTFT and Z Transform analysis of Recursive & Non-Recursive systems – Frequency response of systems characterized by Difference –Equations.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45Periods**

TEXT BOOKS:

*1. Alan V.Oppenheim, Alan S.Willsky and S.Hamid Nawab, "**Signals & Systems**", Prentice-Hall of India, Second Edition, 2011*

*2. Simon Haykin and Barry Van Veen, "**Signals and Systems**", Wiley India, New Delhi, 2010*

REFERENCE BOOKS:

*1. H P Hsu, Rakesh Ranjan, "**Signals and Systems**", Tata McGraw Hill, 7th Reprint, 2010*

*2. Edward W. Kamen, Bonnie S. Heck, "**Fundamentals of Signals and Systems Using the Web and MATLAB**", Pearson Prentice Hall, 2007.*

*3. John Alan Stuller, "**An Introduction to Signals and Systems**", Thomson, 2008*

*4. M.J.Roberts,"**Signals and Systems, Analysis Using Transform Methods and MATLAB**", Tata McGraw Hill (India), 2nd Edition, 2011.*

COURSE OUTCOMES:

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

CO1: Represent basic continuous time and discrete time signals and systems.

CO2: Analyze and characterize continuous time signals in the Fourier transform and Laplace Transform domain

CO3: Analyze the properties of a discrete time- signal in the Fourier transform and Z transform domain.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	L	M		-	-	-	-	-	-	-	H	L	-
CO2	H	M	L	M		-	-	-	-	-	-	-	H	M	-
CO3	H	M	M	M	M	-	-	-	M	-	-	M	H	L	-
18LPC 305	H	M	M	M	M	-	-	-	M	-	-	M	H	M	-

L - Low, M - Moderate (Medium), H - High

18LPC306	NETWORK THEORY	SEMESTER III

Category: PC

L	T	P	C
3	0	0	3

PRE-REQUISITES: 18LES203 PRINCIPLES OF ELECTRICAL ENGINEERING

COURSE OBJECTIVES:

- This course enables the students to understand network theorems, coupled circuits, frequency domain analysis and two port networks.

UNIT- I: NETWORK THEOREMS	**(9 Periods)**
Mesh and Nodal analysis for DC and AC circuits - Source transformation and duality-Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem (Both DC and AC circuits) Reciprocity theorem, Millman's theorem, and Tellegen's theorem (DC Circuits).	
UNIT- II: NETWORK TOPOLOGIES	**(9 Periods)**
Network topology – graph, tree and loops - incidence matrix - fundamental cut sets – cut set matrix – tie sets – fundamental tie sets – tie set matrix – relationships among incidence matrix, cut set matrix and tie set matrix - Kirchoff's laws in terms of network topological matrices.	
UNIT- III: COUPLED CIRCUITS AND FREQUENCY DOMAIN ANALYSIS	**(9 Periods)**
Coupled Circuits: Self Inductance - Co-efficient of Coupling - Dot Convention Analysis of Coupled Circuits - Ideal Transformer - Analysis of Single Tuned and Double Tuned Circuits. Solution of RL, RC and RLC Circuits to step input and sinusoidal excitation using Laplace Transform - Concept of complex frequency.	
UNIT- IV: NETWORK FUNCTIONS AND SYNTHESIS	**(9 Periods)**
Network functions: driving point and transfer functions-Poles and Zeros, their locations and effects on the time and frequency domain responses-Restriction of poles and zeros in the driving point and transfer function. Network Synthesis: Realizability concept - Hurwitz Polynomials - Positive real functions - Synthesis of R-L, R-C and L-C networks by Foster and Cauer forms.	
UNIT- V: TWO PORT NETWORKS	**(9 Periods)**
Functional classification of networks - Two port networks: Z parameters, Y parameters, Transmission (ABCD) parameters and Hybrid (H) Parameters-Interconnection of two port networks-Conditions for reciprocity and symmetry- Symmetrical properties of T and π networks-Basics of Asymmetrical networks.	

Contact periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Van Valkenberg M.E., "**Network Analysis**", 3rd edition, Prentice Hall International Edition, 2007.*
2. *Sudhakar A. and Shyammohan S. Pillai,"**Circuits and Networks Analysis and Synthesis**", 5thedition McGraw Hill, New Delhi, 2015.*

REFERENCE BOOKS:

1. *Abhijit Chakrabarti, "**Circuit Theory Analysis & Synthesis**", 7th Revised Edition, Dhanpath Rai & Sons, New Delhi, 2018.*
2. *Smarajit Ghosh, "**Network Theory Analysis and Synthesis",** 1st edition, Prentice Hall of India, New Delhi, 2015.*
3. *Roy Choudhury, "**Networks and systems**", 2nd edition, New Age Science, 2009.*
4. *Hayt W. H., Kemmerly J. E. and Durbin S. M., "**Engineering Circuit Analysis**", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.,2008.*

COURSE OUTCOMES:

Upon completion of the course, the student will have

CO1: Ability to analyze electrical circuits using network theorems.
CO2: Ability to understand the network topologies.
CO3: Knowledge on Coupled circuits
CO4: Ability to realize network functions.
CO5: Knowledge on two port networks and parameters.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	M	H	H	L	-	-	-	-	-	-	-	-	H	L	-
CO2	M	H	H	L	-	-	-	-	-	-	-	-	H	L	-
CO3	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
CO4	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
CO5	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
18LPC 306	H	H	H	L	-	-	-	-	-	-	-	-	H	L	-

L - Low, M - Moderate (Medium), H - High

18LMC3Z7	ENVIRONMENTAL SCIENCES AND ENGINEERING *(Common to all branches)*	SEMESTER III

Category: MC

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

L	T	P	C
3	0	0	0

- The course is aimed at creating awareness among students and also to inseminate the critical ideas of preserving environment.

UNIT I: ENVIRONMENTAL RESOURCES	**(9 Periods)**
Natural resources-Forest – benefits, over exploitation, deforestation & consequences – Water-unique features, hydrological cycle & over exploitation – Food -effect of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications- Energy resources - renewable & non-renewable resources - wind, solar and tidal-harnessing methods.	
UNIT II: ECO SYSTEM AND BIODIVERSITY	**(9 Periods)**
Ecology - ecosystem, physical and chemical components of ecosystem, biological components of ecosystem, forest ecosystem, desert ecosystem and pond ecosystem, Energy fLow in ecosystem, nitrogen cycle and carbon dioxide cycle, food pyramid, Ecological succession, Biodiversity - types, values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity – in situ – ex situ conservation.	
UNIT III: ENVIRONMENTAL POLLUTION	**(9 Periods)**
Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates, control methods - cyclone separator and electrostatic precipitator, water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollutants, soil pollution- sources, effects and control, noise pollution - decibel scale , sources, effects and control.	
UNIT IV: ENVIRONMENTAL THREATS	**(9 Periods)**
Acid rain, greenhouse effect, global warming and ozone depletion, disaster management - flood, drought, earthquake and tsunami, Threats to biodiversity-destruction of habitat, habit fragmentation-hunting, over exploitation and man-wildlife conflicts, The IUCN red list categories, status of threatened species.	
UNIT V: SOCIAL ISSUES AND ENVIRONMENT	**(9 Periods)**
Sustainable development- sustainable technologies, need for energy and water conservation, rain water harvesting, water shed management, waste land reclamation, Pollution control Act, Wild life protection act, Forest conservation act, population growth- exponential and logistic growth, variation in population among nations, population policy, women and child welfare programs, role of information technology in human and health, HIV/AIDS - effects and preventive measures.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Sharma J.P., **"Environmental Studies"**, 3rd Edition, University Science Press, New Delhi 2009.*
2. *Anubha Kaushik and C.P.Kaushik, **"Environmental Science and Engineering"**, 3rd Edition, New age International Publishers, New Delhi, 2008.*

REFERENCE BOOKS:

1. *R.K.Trivedi, **"Hand book of Environmental laws, Rules, Guidelines, Compliances and Standards",** Vol.I&II, Environ Media, 2006.*
2. *G.TylerMiller, JR, **"Environmental Science"**, Tenth Edition, Thomson BROOKS / COLE Publishing, 2004.*
3. *Gilbert M.Masters, **"Introduction to Environmental Engineering and Science"**, 2nd Edition, Pearson Education, 2004.*

COURSE OUTCOMES:

Upon the completion of the course, Students will be able to

CO1: To know about the various environmental resources, the effective utility and problems accompanied in over exploitation.

CO2: To acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.

CO3: To be aware of the sources of various types of pollution, their ill effects and preventive methods.

CO4: To understand the environmental threats, Acid rain, Green house effect and Ozone depletion and natural disasters.

CO5: To create an idea about sustainable development and social issues.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	L	H	L	M	M	M	M	M	M	L	L	L	L	M
CO2	M	L	L	L	L	L	L	L	L	L	L	L	M	L	L
CO3	L	L	H	L	L	L	M	M	L	M	L	L	L	L	L
CO4	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L
CO5	M	L	H	L	L	L	H	H	L	M	L	L	M	L	M
18LMC 3Z7	M	L	H	L	L	L	M	M	L	M	L	L	L	L	L

L - Low, M - Moderate (Medium), H - High

18LPC308	ELECTRON DEVICES AND CIRCUITS LABORATORY	SEMESTER III

PRE-REQUISITES: NIL **Category: PC**

COURSE OBJECTIVES:

L	T	P	C
0	0	3	1.5

- To study the operation of diodes and applications.
- To study the characteristics of transistors and their parameters.
- To study the characteristics of SCR and application of UJT.

PRACTICALS	1. Diode Characteristics and applications. 2. BJT Characteristics and parameters. 3. Design of biasing circuits for BJT 4. Determination of Stability factor of BJT circuits 5. JFET, MOSFET Characteristics and parameters. 6.Design of biasing circuits for MOSFET 7. SCR characteristics. 8. Sawtooth waveform generation using UJT 9. Design of Wave shaping Circuits. 10.Design of rectifiers with L and π Section Filters 11.Design of Regulated Power Supplies.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

REFERENCE BOOKS:

1. *Robert Boylestead and Louis Nashelsky, "**Electron Devices and Circuits Theory**", Prentice Hall of India, 11th Edition, 2015.*
2. *D. Neamen , D. Biswas "**Semiconductor Physics and Devices**," McGraw-Hill Education, 4th Edition, 2012.*
3. *Millman & Halkias : "**Integrated Electronics**", MGH. 2009.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: Ability to analyze the characteristics of diodes and its applications.
CO2: Ability to analyze the characteristics and biasing circuits of BJT and FET.
CO3: Ability to analyze the characteristics of SCR and application of UJT

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	-	L	-	M	-	-	-	M	L	-	-	H	H	-
CO2	H	-	L	-	M	-	-	-	M	L	-	-	H	H	-
CO3	H	-	L	-	M	-	-	-	M	L	-	-	H	H	-
18LPC 308	H	-	L	-	M	-	-	-	M	L	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LPC309	DIGITAL CIRCUITS LABORATORY	SEMESTER III

PRE-REQUISITES: NIL **Category: PC**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To Design, and implement the combinational and sequential logic circuits

PRACTICALS	**LIST OF EXPERIMENTS** 1. Verification of Boolean Theorems using basic gates. 2. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters. 3. Design and implement Half/Full Adder and Subtractor. 4. Design and implement combinational circuits using MSI devices: • 4 – bit binary adder / subtractor • Parity generator / checker • Magnitude Comparator • Application using multiplexers 5. Verification of flip flops 6. Design and implement sequential circuits: • shift-registers • synchronous counters • asynchronous counters 7. Coding combinational circuits using HDL. 8. Coding sequential circuits using HDL. 9. Design and implementation of a simple digital system (Mini Project).

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45Periods** **Total: 45Periods**

REFERENCE BOOKS:

*1. Morris Mano, "**Digital Design**", 4th Edition, Pearson Education, 2011*

*2. A.Anand Kumar, "**Fundamentals of Digital Circuits**", 2nd Edition, PHI Learning Pvt. Ltd, NewDelhi,2011.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: Implement simplified combinational circuits using logic gates

CO2: Implement combinational and sequential circuits

CO3: Simulate combinational and sequential circuits using HDL

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	H	-	M	-	M	-	-	-	M	L	-	M	H	H	-
CO2	H	-	M	-	M	-	-	-	M	L	-	M	H	H	-
CO3	H	-	M	-	M	-	-	-	M	L	-	M	H	H	-
18LPC 309	H	-	M	-	M	-	-	-	M	L	-	M	H	H	-

L - Low, M - Moderate (Medium), H - High

18LBS401	PROBABILITY THEORY AND RANDOM PROCESSES	SEMESTER IV

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To gain the knowledge of basic probability concepts
- To understand the statistical distributions both discrete and continuous cases
- To be familiar with statistical averages regarding one or more random variables
- To acquire knowledge of Random process and Markov chains.
- To acquire knowledge of queueing models with finite/infinite capacity in single/multi servers.

UNIT I: PROBABILITYAND RANDOMVARIABLES	**(9 Periods)**
Samplespaces–Events-ProbabilityAxioms–ConditionalProbability–IndependentEvents–Baye'sTheorem. Random Variables**:** Distribution Functions–Expectation–Moments -Moment Generating Functions.	
UNIT II: PROBABILITY DISTRIBUTIONS	**(9 Periods)**
Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Gamma, Weibull (Mean, Variance and Simple problems). Functions of random variables.	
UNIT III: TWO DIMENSIONAL RANDOM VARIABLES	**(9 Periods)**
Joint distributions – Marginal Distributions – Conditional distributions – Covariance – Correlation and Regression – Transformation of random variables – Central Limit Theorem.	
UNIT IV: RANDOM PROCESSES	**(9 Periods)**
Definition and Examples - first and Second order, strictly stationary, Wide sense stationary and ergodic processes- Markov processes – Poisson processes - Birth and Death processes - Markov chains -Transition probabilities - Limiting distributions.	
UNIT V: QUEUEING THEORY	**(9 Periods)**
Markovian models-M/M/1 and M/M/C, finite and infinite capacity, M/G/1 queue (steady state solutions only) Pollazack Khintchine formula-Special cases.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1.Veerarajan T., "**Probability and Random Processes**" (with Queueing Theory and Queueing Networks),McGraw Hill Education (India)Pvt Ltd., New Delhi, Fourth Edition,2016.*

REFERENCE BOOKS:

1. *Gupta S.C and Kapoor V.K., "**Fundamentals of Mathematical Statistics**", Sultan Chand & Sons, New Delhi, 2015.*
2. *Gupta S.P, "**Statistical Methods**", Sultan Chand & Sons, New Delhi, 2015.*
3. *Trivedi K.S, "**Probability and Statistics with Reliability, Queuing and Computer Science Applications**", Prentice Hall of India, New Delhi.*
4. *Hwei Hsu, "**Schaum's outline series of Theory and Problems of Probability and Random Process**", Tata McGraw Hill Publishing Co., New Delhi, 2015.*
5. *Kandasamy, Thilagavathy and Gunavathy, "**Probability and Random Process**", S.Chand & Co, Ramnagar, New Delhi, Reprint 2013.*
6. *Roy D Yates, "**Probability and Stochastic Processes a friendly introduction for Electrical and Computer engineers"**, John Wiley & sons, third edition 2015.*

COURSE OUTCOMES:

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

CO1: Understand probability axioms and calculate expected values through moment generating functions
CO2: Identify various probability distributions of discrete and continuous random variables.
CO3: Understand the concept of two dimensional random variables
CO4: Understand the first and second order stationary process and Markovian processes.
CO5: Utilize queuing models in engineering problems.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M	H	H	M	L	L	M	H	M	L	L
CO2	H	H	M	L	M	M	L	L	L	M	L	M	M	L	L
CO3	H	H	H	L	L	L	L	L	M	M	L	M	M	M	M
CO4	H	H	H	M	M	L	M	L	M	L	L	M	M	L	M
CO5	H	H	H	M	M	L	M	M	M	L	M	H	M	M	M
18LBS 401	H	H	H	H	M	H	H	M	M	M	M	H	M	M	M

L - Low, M - Moderate (Medium), H - High

18LES402	ELECTRO MAGNETIC WAVES	SEMESTER IV

Category: ES

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

* To have in-depth knowledge on static electric and magnetic fields
* To study the behavior of Electromagnetic waves in various medium and waveguides.
* To have in-depth knowledge on transmission line

UNIT I: STATIC ELECTRIC FIELD	**(9 Periods)**
Vector analysis- Orthogonal co-ordinate systems- Vector Algebra, Coordinate Systems, Vector differential operator, Gradient, Divergence, Curl, Divergence theorem, Stokes theorem, Coulombs law, Electric field intensity, Point, Line, Surface and Volume charge distributions, Electric flux density, Gauss law and its applications, Gauss divergence theorem, Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density	
UNIT II: CONDUCTORS AND DIELECTRICS	**(9 Periods)**
Conductors and dielectrics in Static Electric Field, Current and current density, Continuity equation, Polarization, Boundary conditions, Method of images, Resistance of a conductor, Capacitance, Parallel plate, Coaxial and Spherical capacitors, Boundary conditions for perfect dielectric materials, Poisson's equation, Laplace's equation, Solution of Laplace equation, Application of Poisson's and Laplace's equations.	
UNIT III: STATIC MAGNETIC FIELDS	**(9 Periods)**
Biot -Savart Law, Magnetic field Intensity, Estimation of Magnetic field Intensity for straight and circular conductors, Ampere's Circuital Law, Point form of Ampere's Circuital Law, Stokes theorem, Magnetic flux and magnetic flux density, The Scalar and Vector Magnetic potentials, Derivation of Steady magnetic field Laws.	
UNIT IV: MAGNETIC FORCES AND MATERIALS	**(9 Periods)**
Force on a moving charge, Force on a differential current element, Force between current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions involving magnetic fields, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance, Basic expressions for self and mutual inductances, Inductance evaluation for solenoid, toroid, coaxial cables and transmission lines, Energy stored in Magnetic fields.	
UNIT V: TIME VARYING FIELDS AND MAXWELL'S EQUATIONS	**(9 Periods)**
Fundamental relations for Electrostatic and Magnetostatic fields, Faraday's law for Electromagnetic induction, Transformers, Motional Electromotive forces, Differential form of Maxwell's equations, Integral form of Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Poynting's theorem, Time harmonic fields, Electromagnetic Spectrum.	

Contact periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

*1.William H.Hayt, "**Engineering Electromagnetics**", Tata McGraw-Hill,2014.*
*2.Edward.C.Jordan & Keith.G.Balmai,, "**Electromagnetic Waves and Radiating Systems**", Prentice Hall of India,1995*

REFERENCE BOOKS:
*1. David K.Cheng , "**Field and Wave Electromagnetics**" , Pearson Edition ,2015.*
*2. D.J. Griffiths, "**Introduction to electrodynamics**", 4th ed., Pearson (India), 2013*
*3. UmeshShinha, "**Electromagnetic Theory and its Applications**", Satya Prakashan,1996.*
*4. Gangadhar.K.A, "**FieldTheory**" Khanna Publishers, 2002.*
*5. B.M. Notaros, "**Electromagnetics**", Pearson: New Jersey, 2011.*

COURSE OUTCOMES:

Upon completion of the course, the students would be able to:

CO1: Analyze field potentials due to static changes and static magnetic fields
CO2: Explain how materials affect electric and magnetic fields.
CO3: Analyze the relation between the fields under time varying situations and the principles of propagation of uniform plane waves.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	H	M	-	-	H	-	-	-	-	H	H	M	-
CO2	L	M	L	M	-	-	L	-	-	-	-	H	H	M	-
CO3	L	L	H	M	-	-	H	-	-	-	-	H	M	H	-
18LES 402	M	M	H	M	-	-	H	-	-	-	-	H	H	M	-

L - Low, M - Moderate (Medium), H - High

18LES403	ANALOG CIRCUITS	SEMESTER IV

PRE-REQUISITES: 18LPC303 ELECTRON DEVICES AND CIRCUITS **Category: ES**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the small signal models and amplifiers of BJT and FET.
- To understand large signal amplifers and time base generator circuits.

UNIT- I: SMALL SIGNAL ANALYSIS OF TRANSISTORS	**(9 Periods)**
BJT: Equivalent Circuit Model - Hybrid Pi Model – Complete Hybrid Equivalent Model – Approximate Hybrid Equivalent Circuit –Input Resistance –Output Resistance- Voltage Gain – Current Gain Calculations - Application of Small Signal Equivalent Circuits. FET: JFET Small Signal Model – Transconductance – Input Impedance – Output Impedance- Voltage gain Calculations - Modeling the Body Effect – MOSFET Small Signal Equivalent Model.	
UNIT- II: ANALYSIS OF BJT AMPLIFIERS	**(9 Periods)**
BJT: Analysis of Single Stage CE, CB and CC Amplifiers – Comparison of CE, CB and CC Circuits - Low Frequency Analysis – Frequency Limitations - High Frequency Model and Analysis – Darlington pair connection – RC Coupled CE amplifier - Multi stage Frequency effects- Square wave Testing.	
UNIT- III: ANALYSIS OF FET AMPLIFIERS	**(9 Periods)**
FET: Single Stage CS, CG and CD Amplifiers – Comparison of CS, CG and CD Circuits - Low Frequency Analysis- Miller Effect Capacitance– Miller's Theorem - High Frequency Model and Analysis – Single stage MOSFET amplifiers.	
UNIT- IV: LARGE SIGNAL AMPLIFIERS	**(9 Periods)**
Classification of Power amplifiers -Class A,B,C,D,E,F and S Operations- Conversion Efficiency - Harmonic distortion - Cross over Distortion - Transformer Coupled Class A Amplifier - Complementry Symmetry Class B Push Pull Amplifier – Heat Sink - Class C operation – Class AB Push Pull Complementry Output Stages – MOSFET based Class D Power Amplifiers.	
UNIT- V: FEEDBACK AMPLIFIERS AND TIME BASE GENERATORS	**(9 Periods)**
Basic feedback concepts – Properties of Negative Feedback – basic Feedback Topologies - Analysis of voltage and current feedback amplifiers – Bistable multivibrator -Voltage Time Base Circuits – Current Time Base Circuits.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Robert Boylestead and Louis Nashelsky, "**Electron Devices and Circuits Theory**", Prentice Hall of India, 11th Edition, 2015.*
2. *Donald A.Neaman, "**Electronic Circuit Analysis**", McGraw-Hill Education., 4th Edition, 2017*

REFERENCE BOOKS:

1. *Sedra and Smith, "**Microelectronic Circuits**", Oxford University Press, 5th Edition, 2009.*
2. *Millman and Halkias.C, "**Integrated Electronics**", Tata McGraw Hill, 2nd Edition, 2010.*
3. *S.Salivahanan, N.Suresh Kumar and A. Vallavaraj. "**Electronic Devices and Circuits**",2nd edition TMH,2010.*
4. *Thomas.L.Floyd, "**Electronic Devices: Conventional Current version**", Pearson, 9th Edition, 2015.*
5. *B.Visvesvara Rao, K.Raja Rajeswari, P.Chalam Raju Pantulu and K.Bhaskara Rama, "**Electronic Circuit Analysis**", Pearson, 1st Edition, 2012.*

COURSE OUTCOMES:

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

CO1: Analyze the parameters of BJT and FET small signal model

CO2: Design and analyze the characteristics of BJT and FET amplifiers

CO3: Explain the operation, applications of Power amplifiers and design feedback amplifiers & time base circuits

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
CO3	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
18LES 403	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L

L - Low, M - Moderate (Medium), H - High

18LPC404	ANALOG COMMUNICATION	SEMESTER IV

Category: PC

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of various analog modulations and their spectral characteristics.
- To understand the properties of random process.
- To know the effect of noise on communication systems.
- To study the basic information theory with channel coding theorem.

UNIT I: AMPLITUDE MODULATION SYSTEMS	**(9 Periods)**
Introduction – communication system model – Need for modulation - Amplitude Modulation -DSB-FC - Bandwidth Requirements- Power relations - Suppressed carrier systems – DSB-SC, SSB-SC - Time and Frequency domain description of AM techniques - Generation and detection of DSB-FC waves – Envelope Detector - Generation and detection of DSB-SC waves - Balanced Modulator, Ring Modulator, Coherent detection –Costas Loop - Generation and detection of SSB-SC waves - Phase discrimination method, Coherent detection – Vestigial Sideband Modulation - Comparison of AM systems.	
UNIT II: ANGLE MODULATION SYSTEMS	**(9 Periods)**
Phase and Frequency Modulation; Single tone, Narrow Band and Wideband FM; Transmission Bandwidth; FM Generation: Direct method and Armstrong method- Demodulation of FM Signal- Balanced Slope detector - FM Discriminator- PLL as FM Demodulator.	
UNIT III NOISE THEORY	**(9 Periods)**
Gaussian Process - Central limit theorem - Noise – Shot noise, Thermal noise and white noise; Narrow band noise, Noise temperature; Noise Figure.	
UNIT IV PERFORMANCE OF CW MODULATION	**(9 Periods)**
Superheterodyne Radio receiver and its characteristic; SNR; Noise in DSBSC systems using coherent detection; Noise in AM system using envelope detection- Noise in FM system; FM threshold effect; Pre-emphasis and De-emphasis in FM; Comparison of performances, FDM.	
UNITV SAMPLING & WAVEFORM CODING	**(9 Periods)**
Low pass sampling theorem – Aliasing- Signal Reconstruction-Quantization - Uniform & Nonuniform quantization - quantization noise - Pulse Modulation-PAM, PPM and PDM, PCM – Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles- Linear Predictive Coding TDM-Digital Multiplexers.	

Contact periods

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1. B.P.Lathi, **"Modern Digital and Analog Communication Systems",** 3rd Edition, Oxford University Press, 2007.*
*2. Simon Haykin, "**Communication Systems",** John Wiley & sons, NY, 4th Edition, 2001.*

REFERENCE BOOKS:

*1. J.G.Proakis, M.Salehi, **"Fundamentals of Communication Systems",** Pearson Education 2006.*
*2 Dennis Roddy & John Coolen –**"Electronic Communication"** (IV Ed.), Prentice Hall of India.*
*3. H P Hsu, Schaum Outline Series - "**Analog and Digital Communications**" TMH 2006*
*4. Herbert Taub & Donald L Schilling – "**Principles of Communication Systems"** (3rd Edition) – Tata McGraw Hill, 2008.*

COURSE OUTCOMES:

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

CO 1: Gain knowledge on amplitude modulation and angle modulation schemes
CO 2: Apply the concepts of random process to the design of communication systems and analyze the noise performance of AM and FM systems.
CO 3: Acquire knowledge on sampling and pulse modulation methods

COURSE ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPC 404	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPC405	MICROPROCESSORS AND MICROCONTROLLERS	SEMESTER IV

Category: PC

PRE-REQUISITES: 18LPC304 DIGITAL SYSTEM DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the Architecture of 8086 microprocessor.
- To learn the design aspects of I/O and Memory Interfacing circuit.
- To interface microprocessors with supporting chips.
- To study the Architecture of 8051 microcontroller.
- To design a microcontroller based system.

UNIT- I: THE 8086 MICROPROCESSOR	**(9 Periods)**
Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.	
UNIT- II: 8086 SYSTEM BUS STRUCTURE	**(9 Periods)**
8086 signals – Basic configurations – System bus timing – System design using 8086 – IO programming – Introduction to Multiprogramming – System Bus Structure - Multiprocessor configurations – Co-processor, closely coupled and loosely Coupled configurations- Introduction to advanced processors.	
UNIT- III: I/O INTERFACING	**(9 Periods)**
Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.	
UNIT- IV : MICROCONTROLLER	**(9 Periods)**
Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits- Instruction set- Addressing modes - Assembly language programming.	
UNIT- V :INTERFACING MICROCONTROLLER	**(9 Periods)**
Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation, Comparison of Microprocessor, Microcontroller, PIC and ARM processors.	

Contact periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Yu-Cheng Liu, Glenn A.Gibson, — **Microcomputer Systems**: The 8086 / 8088 Family - Architecture, Programming and Design, Second Edition, Prentice Hall of India, 2007. (UNIT I-III)*
2. *Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, —**The 8051 Microcontroller and Embedded Systems**: Using Assembly and C, Second Edition, Pearson education, 2011. (UNIT IV-V)*

REFERENCE BOOKS:

1. *Doughlas V.Hall,-"**Microprocessors and Interfacing, Programming and Hardware"**, TMH, 2012.*
2. *A.K.Ray,K.M.Bhurchandi, "**Advanced Microprocessors and Peripherals**" 3rd edition, Tata McGrawHill, 2012.*
3. *Krishna Kanth, "**Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051**", Prentice Hall of India, 2011.*
4. *Kenneth J.Ayala, "**The 8051 Microcontroller**" 3rd edition, Thompson Delmar Learning, 2007, New Delhi.*

COURSE OUTCOMES:

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

CO1: Understand and execute programs based on 8086 microprocessor.
CO2: Design Memory Interfacing circuits.
CO3: Design and interface I/O circuits.
CO4: Design and implement 8051 microcontroller based systems

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	H	-	-	-	-	-	-	-	-	L	H	M	-
CO2	M	M	H	-	-	-	-	-	-	-	-	L	H	M	-
CO3	M	M	H	-	-	-	-	-	-	-	-	L	H	M	-
CO4	M	M	H	-	-	-	-	-	-	-	-	L	H	M	-
18LPC 405	M	M	H	-	-	-	-	-	-	-	-	L	H	M	-

L - Low, M - Moderate (Medium), H - High

18LPC406	ANALOG INTEGRATED CIRCUITS	SEMESTER IV

Category: PC

PRE-REQUISITES: 18LPC303 ELECTRON DEVICES AND CIRCUITS

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To understand the characteristics and applications of Operational amplifiers
- To design waveform generator circuits using Operational amplifiers
- To design filters and data converters using Operational amplifiers
- To understand the operation and applications of special function Ics

UNIT- I :BASICS OF OPERATIONAL AMPLIFIERS	**(9 Periods)**
Differential amplifier-current mirror-Widlar current mirror - Building blocks of 741 operational amplifier-I/O stages, gain stage and level translator stage of 741op-amp -Characteristics of an Ideal Operational Amplifier-Op-amp parameters, DC & AC performance characteristics- frequency response - Introduction to Low power Op.amp.	
UNIT- II :APPLICATIONS OF OPERATIONAL AMPLIFIERS	**(9 Periods)**
Linear applications: voltage folLower - inverting, non inverting amplifiers-summing, scaling, averaging amplifiers-instrumentation amplifiers-difference amplifier **Nonlinear applications:** Integrator-differentiator-precision half wave & full wave rectifiers- peak detector-sample & hold circuit-log & anti-log amplifiers. **Open loop applications:** Comparator-zero crossing detector- Schmitt trigger.	
UNIT- III :OSCILLATORS AND MULTIVIBRATORS	**(9 Periods)**
Barkhausen criterion- loop gain -Design of Oscillators: RC phase shift oscillator- Wien bridge oscillator- LC Oscillators: Hartley oscillator - Colpitts oscillator - Clapp oscillator- Crystal oscillator - Triangular wave generator-Saw tooth wave generator - IC 555 timer: Functional block diagram and description of Astable & Monostable multivibrators using IC555	
UNIT- IV :ACTIVE FILTERS AND DATA CONVERTERS	**(9 Periods)**
Active filters - Sallen-Key filter structure- Design of I order and II order Butterworth filters: Low pass, High pass, Band pass filters- Switched capacitor filter- Data Converters: D/A converter – specifications - weighted resistor type, Voltage Mode and Current-Mode R 2R Ladder types - switches for D/A converters, high speed sample-and-hold circuits- A/D Converters – specifications - Flash type - Successive Approximation type - Dual Slope type A/D converters.	
UNIT- V :PLL AND SPECIAL FUNCTION ICS	**(9 Periods)**
Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK demodulation and Frequency synthesizing -IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Voltage to Frequency converter- Audio Power amplifier IC.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1.D.RoyChoudhry and Shail Jain, "**Linear Integrated Circuits**", New Age International Pvt. Ltd.,4th Edition 2010.*
*2.Ramakant A. Gayakwad, "**OP-AMPs and Linear Integrated Circuits**", 4th Edition, Prentice Hall / Pearson Education, 2015.*

REFERENCE BOOKS:

*1.Sergio Franco, "**Design with Operational Amplifiers and Analog Integrated Circuits**", 4th Edition, Tata McGraw-Hill, 2014.*
*2.Gray and Meyer, "**Analysis and Design of Analog Integrated Circuits**", Wiley International, 2009.*
*3.S.Salivahanan and V.S. Kanchana Bhaaskaran, "**Linear Integrated Circuits**", Tata McGraw Hill Publishing company Ltd, 1st Edition, 2009.*
*4.B.Somanathan Nair, "**Linear Integrated Circuits, Analysis, Design and Applications**", Wiley India Publishers, 1st Edition, 2009.*

COURSE OUTCOMES:

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

CO1: Explain DC & AC characteristics and open loop, closed loop applications of Op.Amp
CO2: Design and analyze oscillators, active filters and data converters using Op.Amp
CO3: Design multivibratorusin IC 555 and explain the operation & applications of PLL, special function ICs

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
CO3	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
18LPC 406	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L

L - Low, M - Moderate (Medium), H - High

18LMC4Z7	CONSTITUTION OF INDIA *(Common to all branches)*	SEMESTER IV

Category: MC

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	0

COURSE OBJECTIVES:

1. To know about Indian constitution.
2. To know about central and state government functionalities in India.
3. To know about Indian society.

UNIT – I : INTRODUCTION	**(9 Periods)**
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Role of the Election Commission.	
UNIT – II : STRUCTURE AND FUNCTION OF CENTRAL AND STATE GOVERNMENT	**(9 Periods)**
Union Government – Structures of the Union Government and Functions – President – Vice President– Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review. State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.	
UNIT – III : CONSTITUTION FUNCTIONS OF INDIA AND INDIAN SOCIETY	**(9 Periods)**
Indian Federal System – Central – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India. Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.	
UNIT – IV : POLICIES AND ACTS - GENERAL	**(9 Periods)**
Insurance and Bonding – Laws Governing Sale, Purchase and use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax , Excise and Custom duties and their Influence on Construction Cost – Legal Requirements for Planning – Property Law– Agency Law – Local Government Laws for Approval.	
UNIT – V : POLICIES AND ACTS ON INFRASTRUCTURE DEVELOPMENT	**(9 Periods)**
A Historical Review of the Government Policies on Infrastructure – Current Public Policies on Transportations – Power and telecom Sector – Plans for Infrastructure Development – Legal framework for Regulating Private Participation in Roads and Highways – Ports and Airport and Telecom.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Durga Das Basu, **"Introduction to the Constitution of India"**, Prentice Hall of India, New Delhi,2018*
2. *R.C.Agarwal, **"Indian Political System"**, S.Chand and Company, New Delhi, 2004.*
3. *Maciver and Page, **" Society: An Introduction Analysis"**, Mac Milan India Ltd., New Delhi,2007*
4. *K.L.Sharma, **"Social Stratification in India: Issues and Themes"**, Jawaharlal Nehru University, New Delhi,2006*

REFERENCE BOOKS:

1. *M.Laxmikanth, "Indian Polity",Mcgraw Hill Education (India)Private limited,2016*
2. *Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi,2018*

COURSE OUTCOMES:

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

CO1: Understand and abide the rules of the Indian constitution.
CO2: Understand the functions of Central government.
CO3: Understand the function of state government.
CO4: Understand the various constitutional functions.
CO5: Understand the different culture among the people of India.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	M	M	-	-	-	-	M	-	-	L	-
CO2	-	-	-	-	-	L	-	-	-	-	-	M	-	L	-	-
CO3	-	-	-	-	-	L	-	-	-	-	-	M	-	-	-	-
CO4	-	-	-	-	-	L	-	-	-	-	-	L	-	L	-	-
CO5	-	-	-	-	-	L	L	-	-	-	-	L	-	L	L	-
18LMC 4Z7	-	-	-	-	-	L	L	-	-	-	-	M	-	L	L	-

L - Low, M - Moderate (Medium), H - High

18LPC408	ANALOG CIRCUITS AND IC LABORATORY	SEMESTER IV

CATEGORY: PC

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To Design, Construct and Demonstrate analog circuits
- To Design, Construct and Demonstrate linear IC's applications

PRACTICALS	**LIST OF EXPERIMENTS** 1. Design and testing of single stage BJT amplifier 2. Design and testing of RC Coupled BJT amplifier 3. Design and testing of single stage JFET/MOSFET amplifier 4. Design and testing of Power amplifier (Class A, Class B) 5. Design and testing of feedback amplifiers 6. DC and AC characteristics of op-amp 7. Simple applications of op-amps(Slew rate verifications, inverting and non-inverting amplifier, Adder, Integrator and Differentiator) 7. Design and testing of comparators(magnitude comparator, zero crossing detector, peak detector) 8. Design of Schmitt trigger circuit 9. Design of Astable and Monostable multivibrator circuits using 555 timer IC 10. Design of active LPF and HPF.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCE BOOKS:

1. *Robert Boylestead and Louis Nashelsky, "**Electron Devices and Circuits Theory**", Prentice Hall of India, 11th Edition, 2015.*
2. *D.RoyChoudhryand Shail Jain, "**Linear Integrated Circuits**", New Age International Pvt. Ltd.,4th Edition 2010.*
3. *Ramakant A. Gayakwad, "**OP-AMPs and Linear Integrated Circuits**", 4th Edition, Prentice Hall / Pearson Education, 2015.*

COURSE OUTCOMES:

Upon completion of the course, the students will able to

CO1: Ability to design and analyze amplifiers using BJT and JFET/MOSFET

CO2: Familiarization with characteristics and applications of Op-amp

CO3: Ability to design multivibrators using IC555 Timer

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO2	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO3	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
18LPC 408	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LPC409	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	SEMESTER IV

PRE-REQUISITES: NIL **Category: PC**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES

- To Introduce ALP concepts, features and Coding methods
- Write ALP for arithmetic and logical operations in 8086 and 8051
- Differentiate Serial and Parallel Interface
- Interface different I/Os with Microprocessors

PRACTICALS	**LIST OF EXPERIMENTS** **8086 Programs using kits and MASM** 1. Basic arithmetic and Logical operations 2. Move a data block without overlap 3. Code conversion, decimal arithmetic and Matrix operations. 4. Floating point operations, string manipulations, sorting and searching 5. Password checking, Print RAM size and system date 6. Counters and Time Delay **Peripherals and Interfacing Experiments** 7. Traffic light controller 8. Stepper motor control 9. Digital clock 10. Key board and Display 11. Printer status 12. Serial interface and Parallel interface 13. A/D and D/A interface and Waveform Generation **8051 Experiments using kits** 14. Basic arithmetic and Logical operations 15. Square and Cube program, Find 2's complement of a number 16. Unpacked BCD to ASCII

Contact periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total:45 Periods**

REFERENCE BOOKS:

*1. Krishna Kant, "**Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096**", PHI, 2011.*
*2. Ajay Deshmukh, "**Microcontrollers : Theory and Applications**", Tata McGraw Hill, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the students will able to:

CO1: Write ALP Programmes for fixed and Floating Point and Arithmetic operations

CO2: Interface different I/Os with processor

CO3: Generate waveforms using Microprocessors

CO4: Execute Programs in 8051

CO5: Explain the difference between simulator and Emulator

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-
CO2	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-
CO3	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-
CO4	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-
CO5	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-
18LPC 409	M	H	M	-	-	-	-	-	-	L	L	L	M	M	-

L - Low, M - Moderate (Medium), H - High

18LHS501	YOUTH EMPOWERMENT FOR YOGA PRACTICE	SEMESTER -V

PRE-REQUISITES: NIL **Category: HS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To Provide the Value Education to improve the Students' Good character
- To understand physical health, maintaining youthfulness , Moderation in five aspects of life
- To develop Personality , Learning of Introspection and Understanding Cultural Values

UNIT- I: PHILOSOPHY OF LIFE SCIENCE	**(9 Periods)**
Life - Purpose of Life - Philosophy of Life - Law of Nature - Kindness towards living beings Preserving Natural Resources	
UNIT- II: HUMAN VALUES	**(9 Periods)**
Culture - Analysis of Thought - Moralization of Desire - Neutralization of Anger -Eradication of Worry - Blessings and Benefits - Harmonious Friendship - Love and Compassion - Individual Peace	
UNIT- III: SOCIAL VALUES	**(9 Periods)**
Family - Family Peace - Society - Life Style - World Brotherhood - Greatness of Women - Five Duties - Economics - Hygiene and Health Care - Education - Politics - Responsibilities of People	
UNIT- IV: DEVELOPMENT OF MENTAL PROSPERITY	**(9 Periods)**
Prosperity of Mind - Life Force - Bio-Magnetism and Mind - Functions of Mind - Mental Frequency - Ten Stages of Mind - Genetic Centre - Meditation -Value of Spirituality - Universal Magnetism and Bio-Magnetism	
UNIT- V: MAINTENANCE OF PHYSICAL HEALTH	**(9 Periods)**
Structure of Human Body - Three Functional Bodies - Harmony between Body and Life Force - Pain, Disease and Death - Reasons for Disease - Limit and Method in Five Factors - Simplified Physical Exercises - Practice for Simplified Physical Exercises	

Contact Periods:

Lecture:45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Taimini, I.K, **"Glimpses into the Psychology of Yoga",** Theosophical Publishing House, 1973.*
2. *Vethathiri maharishi, 2011, **"Journey of Consciousness",** Vethathiri Publications.*

REFERENCE BOOKS:

*1.Iyankar B.K.S **"The path to Holistic Health",** Dorling kindusly Pvt Ltd, London, 2014*
*2. Vethathiri Maharishi, 2014, **"Simplified Physical Exercises",**Vethathiri Publications.*
*3.Thathuvagnani Vethathiri Maharishi – **"Kayakalpa Yoga"** – First Edition 2009 – Vethathiri Publications .*

COURSE OUTCOMES:

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

CO1: Enable the student to have good physical health.

CO2: Practice mental hygiene

CO3: Possess emotional stability and Cultural values

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
C01	-	-	-	-	-	L	M	H	L	-	-	H	-	-	-
CO2	-	-	-	-	-	L	M	H	L	-	-	H	-	-	-
C03	-	-	-	-	-	L	M	H	L	-	-	H	-	-	-
18LHS501	-	-	-	-	-	L	M	H	L	-		H	-	-	-

L - Low, M - Moderate (Medium), H - High

18LPC502	DIGITAL COMMUNICATION	SEMESTER V

Category: PC

PRE-REQUISITES:NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic concepts of Digital Communication in baseband and passband domains and to give an exposure to error control coding techniques and spread spectrum techniques.

UNIT- I : INFORMATION THEORY	**(9 Periods)**
Measure of information – Entropy – Source coding theorem – Discrete memoryless channels–BEC, BSC – Mutual information – Channel capacity – Shannon Hartley law- Transform coding –Shannon-Fano coding, Huffman Coding, Run length coding, LZW algorithm.	
UNIT- II : ERROR CONTROL CODING TECHNIQUES	**(9 Periods)**
Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes – Convolutional codes – Viterbi decoding.	
UNIT- III : BASEBAND TRANSMISSION	**(9 Periods)**
Comparison of base band and band pass signaling, Geometric representation of signals - Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ - Manchester- ISI – Nyquist criterion for distortionless transmission – Pulse shaping –Correlative coding – Eye pattern – Equalization.	
UNIT- IV :BANDPASS SIGNALING	**(9 Periods)**
ML detection - Correlator and matched filter detection- generation and detection of BPSK, BFSK, QPSK,MSK- BER and Power spectral Density Comparison- M-ary PSK, M-ary FSK - Structure of non-coherent receivers generation and detection of BFSK, DPSK – Principles of QAM – Introduction to Band Pass Sampling theorem.	
UNIT- V :SYNCHRONISATION AND SPREAD SPECTRUM TECHNIQUES	**(9 Periods)**
Carrier, frame and symbol/Chip synchronization techniques, Spread Spectrum - PN Sequences, Direct Sequence and Frequency Hopping Spread Spectrum Systems, BER Analysis, Processing gain and Jamming Margin, Software Defined Radio Concept.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. S. Haykin, — "**Digital Communications"**, John Wiley, 2015.*
*2. B.P.Lathi, **— "Modern Digital and Analog Communication Systems"** 3rd edition, Oxford University Press 2007.*
*3. S.P.Eugene Xavier, **"Statistical theory of Communication",** New Age International Private Limited, 2008.*

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"**, 5/e, Tata Mc Graw Hill Company, 2008.*

COURSE OUTCOMES:

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

CO1: Analyze the error detection and correction capability of codes
CO2: Acquire knowledge on Channel capacity and source coding theorem
CO3: Analyze the spectral characteristics of band pass signaling schemes and their noise performance
CO4: Understand the concept of spread spectrum systems and software defined radio

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPC 502	**M**	**M**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**L**	**H**	**L**	**L**

L - Low, M - Moderate (Medium), H - High

18LPC503	TRANSMISSION LINES AND WAVEGUIDES	SEMESTER V

Category: PC

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This course enables the students to understand the concepts of transmission lines and waveguides.

UNIT- I: FILTERS, ATTENUATORS AND EQUALIZERS	**(9 Periods)**
Constant K and m-derived filters: Low Pass, High Pass, Band Pass and Band Stop filters - T type and Π type attenuators - Series and Shunt equalizers.	
UNIT II: TRANSMISSION LINE THEORY	**(9 Periods)**
Line parameters and transmission constants-Transmission line equation-Physical significance of the equation-Infinite line-Input and transfer impedance-Waveform distortion-Distortion less line-Loading-Reflection phenomena-Reflection loss and insertion loss-Skin and proximity effect-T and pi equivalent of transmission lines.	
UNIT III: LINE AT RADIO FREQUENCIES	**(9 Periods)**
Parameters of open wire line and co-axial line at high frequencies – Standing waves-Standing wave ratio-Input impedance of open and short circuited lines-Relation between VSWR and reflection co-efficient-Quarter wave transformer-Single and double stub matching-Smith chart and its applications.	
UNIT IV: GUIDED WAVES AND RECTANGULAR WAVE GUIDES	**(9 Periods)**
General solutions for TE and TM waves-Waves between parallel planes of perfect conductors-Velocities of wave propagation- Attenuation in parallel plate waveguide-Wave impedance of TE and TM waves in a parallel plate waveguide-Types of waveguides-Mode theory of a Rectangular waveguide(TE and TM waves)-Characteristics of TE and TM waves-Impossibility of TEM waves in rectangular waveguides-Dominant mode -Wave impedances of TE and TM waves -Characteristic impedance of a waveguide-Attenuation factor -Excitation of various modes-Quality Factor.	
UNIT V: CIRCULARWAVEGUIDES AND CAVITYRESONATORS	**(9 Periods)**
Bessel functions-TE and TM modes in circular Waveguides-Wave impedances-Dominant mode-Field configuration- Comparison of Circular and Rectangular waveguides-Excitation of modes-Microwave cavity resonators-Rectangular and circular cavity resonators.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. John D. Ryder, "**Networks, Lines and Fields**", PHI, 2nd edition, 2009.
2. *Edward.C.Jordan & Keith.G.Balmai,, "**Electromagnetic Waves and Radiating Systems**", Prentice Hall of India,1995*

REFERENCE BOOKS:

1. Roy Choudhury, "**Networks and systems**", 2nd edition , New Age Science, 2009.
2. Sudhakar A. and Shyammohan S. Pillai,"**Circuits and Networks Analysis and Synthesis**", 5thedition McGraw Hill, New Delhi, 2015.
3. *S.Baskaran, "**Transmission Lines and Waveguides**", Scitech Publications(India) PVT.LTD,Chennai,2011*
4. *David K.Cheng , "**Field and Wave Electromagnetics**", Pearson Edition ,2015.*
5. Raju.G.S.N, "**Electromagnetic Field Theory and Transmission Lines**", Pearson Education, First Indian print,2005

COURSE OUTCOMES:

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

CO1: Ability to design filters, attenuators and equalizers.
CO2: interpret the Wave propagation in between parallel plates.
CO3: emphasize the significance of different types of waveguides

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
CO2	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
CO3	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-
18LPC 503	H	M	M	-	-	-	-	-	-	-	-	-	H	L	-

L - Low, M - Moderate (Medium), H - High

18LPC504	DIGITAL SIGNAL PROCESSING	SEMESTER V

PRE-REQUISITES: 18LPC305 SIGNALS AND SYSTEMS **Category: PC**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

*****To study DFT and digital filter design algorithms
*To discuss finite word length effects and multi rate signal processing
*To study the fundamentals of Digital signal processors

UNIT I: DISCRETE FOURIER TRANSFORM	**(9 Periods)**
DFT and its properties– FFT algorithms–IFFT-circular convolution– Overlap – add – overlap – save methods.	
UNIT II: INFINITE IMPULSE RESPONSE DIGITAL FILTERS	**(9 Periods)**
Design of analog Butterworth and Chebyshev Filters – Frequency transformation in analog domain Design of IIR digital filters - Impulse invariance techniques, Bilinear transformation – Realization of IIR filters - Direct, cascade and parallel forms.	
UNIT III: FINITE IMPULSE RESPONSE DIGITAL FILTERS	**(9 Periods)**
Symmetric and Anti-symmetric FIR filters – Linear phase FIR filters – FIR Design using window method– rectangular, Hamming and hanning windows – Frequency sampling method – Realization of FIR filters – Linear phase, Traversal structures-comparison of FIR and IIR filters.	
UNIT IV: FINITE WORD LENGTH EFFECTS AND MULTI-RATE SIGNAL PROCESSING	**(9 Periods)**
Fixed point and floating-point number representations – Comparison – Quantization Error - Quantization Noise Power -Finite word length effects -Signal scaling - Introduction to Multi-rate signal processing-Decimation –Interpolation –multistage implementation- Applications	
UNIT V: DIGITAL SIGNAL PROCESSOR	**(9 Periods)**
Harvard and modified Harvard architectures - architecture of C6X processors – Features of C67X processor – Internal architecture – CPU – General Purpose register files – Functional Units and operation – data paths – Control registers - Functional Units and instructions – Parallel and pipeline operations – Interrupts.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. John G Proakis and Manolakis, "**Digital Signal Processing Principles, Algorithms and Applications**", Pearson, Fourth Edition, 2007.*

*2. B. Venkataramani, M. Bhaskar, "**Digital Signal Processor Architecture, Programming and Applications**", Second Edition, 2011.*

REFERENCE BOOKS:

*1. Johny R. Johnson, "**Introduction to Digital Signal Processing**", PHI, 2008*
*2. E.C. Ifeachor and B.W. Jervis, "**Digital signal processing – A Practical approach**", Prentice Hall, 2011*
*3. S.K. Mitra, "**Digital Signal Processing, A Computer Based approach**", Tata McGrawHill, 2011 fourth international edition*

COURSE OUTCOMES:

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

CO1: Exposure to DFT & FFT algorithms
CO2: Ability to design and realize digital IIR filters
CO3: Ability to design and realize digital FIR filters
CO4: Understanding on the finite word length effects
CO5: Exposure to Multirate signal processing and its applications
CO6: Familiarization with DSP architectural features

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
CO2	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
CO3	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
CO4	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
CO5	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
CO6	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-
18LPC 504	H	H	M	-	L	-	-	-	-	-	-	-	H	L	-

L - Low, M - Moderate (Medium), H - High

18LPC507	COMMUNICATION ENGINEERING LABORATORY	SEMESTER V

PRE-REQUISITES: NIL **Category: PC**

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To visualize the effects of sampling and TDM
- To Implement AM & FM modulation and demodulation
- To implement PCM & DM
- To implement FSK, PSK and DPSK schemes
- To implement Equalization algorithms
- To implement Error control coding schemes
- To gain knowledge in Logical link control layer protocols and MAC protocols

PRACTICALS	**LIST OF EXPERIMENTS:** 1. Signal Sampling and reconstruction 2. Time Division Multiplexing 3. AM Modulator and Demodulator 4. FM Modulator and Demodulator 5. Pulse Code Modulation and Demodulation 6. Delta Modulation and Demodulation 7. Observation (simulation) of signal constellations of BPSK, QPSK and QAM 8. Line coding schemes 9. FSK, PSK and DPSK schemes (Simulation) 10. Error control coding schemes - Linear Block Codes (Simulation) 11. Communication link simulation 12. Equalization – Zero Forcing & LMS algorithms(simulation) 13. Study of Software defined Radio System 14. Analysis of Logical link control layer protocols - Stop and Wait, Sliding Window 15. Analysis of MAC protocols - ALOHA, SLOTTED ALOHA,CSMA, CSMA/CD, TOKEN BUS and TOKEN RING

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods

REFERENCE BOOKS:

1.Mathuranathan Viswanathan at Amazon" ***Simulation of DigitalCommunication systems using Matlab"****2013 , Second Edition.*

2. E.S. Gopi " ***Digital Signal Processing for Wireless Communication using Matlab"*** *2016.*

*3. Robert W Heath, "****Digital Wireless communication: Physical layer exploration Lab using NI USRP"****, 2014.*

COURSE OUTCOMES:

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

CO1: Demonstrate their knowledge in base band signaling schemes through implementation of FSK, PSK and DPSK

CO2: Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication system

CO3: Simulate & validate the various functional modules of a communication system

CO4: Ability to compare the performance of Logical link control layer protocols and MAC protocols.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO2	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	M	M	-	-	-	-	-	-	L	L	L	L
CO4	M	M	M	M	M	-	-	-	-	-	-	L	L	L	L
18LPC 507	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L

L - Low, M - Moderate (Medium), H - High

18LPC508	DIGITAL SIGNAL PROCESSING LABORATORY	SEMESTER V

PRE-REQUISITES: 18LPC305-SIGNALS AND SYSTEMS **Category: PC**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To Develop DSP algorithms for signal processing and test them using MATLAB
- To familiarize with the usage of DSP processors
- To test the DSP algorithms using CCS

PRACTICALS	**LIST OF EXPERIMENTS USING SOFTWARE:** 1. Computation of FFT of a signal- Spectral Analysis 2. Linear and circular convolution 3. Design of FIR filters –windowing technique 4. Design of IIR filters – Butterworth, Tchebyshev using – Impulse invariance and Bilinear Transform 5. Coeffecient and Quantization effects on Direct form and cascade form realization of IIR filter 6.Limit Cycle Oscillation 7.Multirate Signal Processing **USING DIGITAL SIGNAL PROCESSOR** 1. Generation of Basic Signals 2. Implementation of convolution 3. Sampling of input signal and display 4. Computation of FFT 5. Implementation of I/II order FIR filter 6. Implementation of I/II order IIR filter

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

REFERENCE BOOKS:

*1. John G Proakis and Manolakis, "**Digital Signal Processing Principles, Algorithms and Applications**", Pearson, Fourth Edition, 2009.*
*2.B. Venkataramani, M. Bhaskar, "**Digital Signal Processor Architecture, Programming and Applications**", Second Edition, 2011*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: Ability to analyze convolution and FFT concepts and it's applications.

CO2: Ability to design and test IIR/FIR digital filters.

CO3: Exposure to coefficient, Quantization effects and Multirate signal processing algorithms.

CO4: Familiarization with DSP starter kit programming using simple examples

CO5: Exposure to DFT/FFT computation algorithms and spectral estimation.

CO6: Ability to design and test IIR/FIR digital filters.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO2	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO3	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO4	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO5	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
CO6	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-
18LPC 508	H	-	H	-	M	-	-	-	M	L	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LHS601	**PROFESSIONAL ETHICS** *(Common to MECH, EEE, ECE, EIE & IT Branches)*	SEMESTER VI

PRE-REQUISITES: NIL

Category: HS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To possess knowledge on ethics, safety, rights, responsibilities and global issues on engineering and technology.

UNIT I : **ENGINEERING ETHICS**	**(9 Periods)**
Senses of 'Engineering Ethics' - Variety of moral issued - Types of inquiry - Moral dilemmas - Moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy – Models of Professional Roles - Theories about right action - Self-interest - Customs and religion - Uses of ethical theories.	
UNIT II : ENGINEERING AS SOCIAL EXPERIMENTATION	**(9 Periods)**
Engineering as experimentation - Engineers as responsible experimenters - Codes of ethics - A balanced outlook on law - The challenger case study.	
UNIT III : **SAFETY**	**(9 Periods)**
Safety and risk - Assessment of safety and risk - Risk benefit analysis and reducing risk - The three mile island and chernobyl case studies.	
UNIT IV : **RESPONSIBILITIES AND RIGHTS**	**(9 Periods)**
Collegiality and loyalty - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights - Intellectual Property Rights (IPR) - Discrimination.	
UNIT V : GLOBAL ISSUES	**(9 Periods)**
Multinational corporations - Environmental ethics - Computer ethics - Weapons development - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership - Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers(IETE)(India).	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Charles E. Harris, Michael S. Pritchard and Michael J. Rabins,* ***"Engineering Ethics – Concepts and Cases",*** *Cengage Learning, 2009*
2. *Mike Martin and Roland Schinzinger* ***"Ethics in Engineering"*** *McGraw-Hill, New York 1996*
3. *Govindarajan M, Natarajan S, Senthil Kumar V. S "****Engineering Ethics****" Prentice Hall of India, New Delhi, 2004*

REFERENCE BOOKS:

1. *Charles D. Fleddermann,* ***"Engineering Ethics",*** *Pearson Education / Prentice Hall, New Jersey,2004 (Indian Reprint)*

*2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "****Engineering Ethics– Concepts and Cases****", Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available).*

*3. John R Boatright, "****Ethics and the Conduct of Business****", Pearson Education, New Delhi, 2003*

*4. Edmund G Seebauer and Robert L Barry, "****Fundamentals of Ethics for Scientists and Engineers****", Oxford University Press, Oxford, 2001*

COURSE OUTCOMES:

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

CO1: Students would internalize ethical behaviour in personal and professional lives.

CO2: Students become responsible employees and citizens.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	H	H	-	-	-	-	-	-	-
CO2	-	-	-	-	-	H	H	H	-	-	-	-	-	-	-
18LHS 601	-	-	-	-	-	H	H	H	-	-	-	-	-	-	-

L - Low, M - Moderate (Medium), H - High

18LPC602	VLSI DESIGN	SEMESTER VI

PRE-REQUISITES: NIL **Category: PC**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

* To introduce various aspects of CMOS logic and CMOS logic networks to realize the VLSI system components

UNIT I: CMOS LOGIC DESIGN	**(9 Periods)**
VLSI Design FLow - Fabrication of CMOS Integrated Circuits - MOSFET Switches - Basic Logic Gates in CMOS - Complex Logic Gates in CMOS - Transmission Gate Circuits - Stick Diagram and Layout Design Rules - Layout of Basic Structures - FET sizing - Physical structure of MOSFETs - CMOS Layers	
UNIT II: CHARACTERISTICS AND ANALYSIS OF CMOS LOGIC	**(9 Periods)**
MOS Threshold Voltage Equation - nFET Current-Voltage Equations - The FET RC Model - DC Characteristics of the CMOS Inverter - Switching Characteristics - Power Dissipation - Transient Response - Analysis of Complex Logic Gates.	
UNIT III: DESIGNING HIGH-SPEED CMOS LOGIC NETWORKS	**(9 Periods)**
Gate delays - driving large capacitive loads - Logical effort - Advanced Logic Circuits: Pseudo-NMOS - Tri-state - clocked - dynamic and dual rail logic	
UNIT IV: VLSI CLOCKING AND TESTING	**(9 Periods)**
VLSI clocking: CMOS clocking styles - Pipelined systems - Clock generation and distribution. VLSI testing -need for testing - manufacturing test principles - design strategies for test - chip level and system level test techniques.	
UNIT V: DESIGN OF VLSI SYSTEMS	**(9 Periods)**
System Specifications – Structural Gate Level Modeling – Switch Level Modeling – Behavioral and RTL Modeling -Transistor Level Realization –Multiplexers - Binary Decoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM - DRAM and Flash Memories - CMOS Clocking Styles.	

Contact Periods:

Lecture:45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1. Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*

*2. N. Westeet. al., "**CMOS VLSI Design**", Third Edition, Pearson Education,2013.*

REFERENCE BOOKS:

*1. Jan M. Rabaey, "**Digital Integrated Circuits: A Design Perspective**", PHI, Second Edition, 2012.*

*2. R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*

*3. Pucknell, "**Basic VLSI Design**", Prentice Hall, 2006.*

COURSE OUTCOMES:

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

CO1: Construct the complex logic circuits with MOSFETs

CO2: Acquire knowledge on characteristicsof CMOS logic to design the high-speed CMOS Logic Networks

CO3: Use clocking styles to design basicVLSI system and testing principles for the device under test

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	L	M	M	L	-	M	H	-	-	H	M	L	M	-
CO2	L	L	H	H	H	-	H	H	-	-	H	-	L	L	-
CO3	L	L	H	H	M	-	H	H	-	-	-	H	L	M	-
18LPC 602	L	L	H	H	H	-	H	H	-	-	H	M	L	M	-

L - Low, M - Moderate (Medium), H - High

18LPC603	ANTENNAS AND WAVE PROPAGATION	SEMESTER VI

PRE-REQUISITES: 18LES402 ELECTROMAGNETIC WAVES **Category: PC**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To understand the antenna fundamentals and parameters.
- To learn radiation characteristics of antenna array and different types of antennas.
- To learn measurements of antenna parameters.
- To understand characteristics of a wave propagation in free space.

UNIT- I : FUNDAMENTALS OF ANTENNA	(9 Periods)
Antenna Parameters: Types of antennas- Radiation mechanism- current distribution on a thin wire antenna- Antenna parameters- Radiation Pattern, Beam solid angle, Radiation intensity, Radiation Power density, Directivity, Gain, Effective aperture, Polarization, Bandwidth, Beam width, antenna impedance, Poynting vector-Friis Transmission formula- Duality of Antennas **Radiation:** Retarded potentials - Radiation fields of oscillating dipole, Half wave Dipole, loop antennas- Power radiated and Radiation Resistance.	
UNIT- II: ANTENNA ARRAYS	**(9 Periods)**
Array of two point sources – Pattern multiplication, Broad side array, End fire array, N-element linear array, Evaluation of null directions and maxima, amplitude distributions, Binomial arrays, Dolph - Chebychev arrays – Log periodic dipole array – Phased array	
UNIT- III: SPECIAL ANTENNAS	**(9 Periods)**
Yagi Uda antenna - Folded dipole - Helical antenna - Normal mode and Axial mode, Horn Antenna- Reflector antennas and their feed systems- Micro strip antennas: Rectangular patch – transmission line model - Quality factor - Bandwidth and Efficiency – Introduction to smart antennas	
UNIT- IV: ANTENNA MEASUREMENTS	**(9 Periods)**
Measurement of Radiation Pattern - Beam Width - Gain - Directivity - Polarization- Input impedance - Bridge method - SWR method –Reflection coefficient-VSWR–Antenna Test Ranges: Elevated ranges-Ground reflection ranges- Anechoic chambers & absorbing materials-Compact Antenna Test Ranges (CATRS).	
UNIT- V: WAVE PROPAGATION	**(9 Periods)**
Modes of propagation - Structure of atmosphere - Characteristics of different ionized regions - Sky wave propagation - Effects of the earth's magnetic field on ionospheric radio wave propagation - Virtual height - Maximum usable frequency - Critical angle - Skip distance - Ionospheric abnormalities - Space wave propagation - Duct propagation.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. John D Kraus, Ronald J Marhefka."**Antenna and Wave Propagation**", 4th edition, Tata McGraw Hill,2010.*

*2. Prasad.K.D, "**Antennas and Wave Propagation**", Sathya Prakashan, 3rd Edition, 2009.*

REFERENCE BOOKS:

1. *Constantine A. Balanis, "**Antenna Theory-Analysis and Design**", 3rd edition, Wiley-India, 2010*
2. *Sisir K Das, Annapurna Das, "**Antenna and Wave Propagation**", Tata McGraw hill Education Pct limited,2013.*
3. *H.Sizun "**Radio Wave Propagation for Telecommunication Applications**", First Indian Reprint, Springer Publications, 2007.*
4. *A.R.Harish and M.Scahidananda, " **Antennas and Wave Propagation**", Oxford University Press, Chennai, 2007.*
5. *R.E.Collin, "**Antennas and Radiowave Propagation**", McGraw Hill,2002.*

COURSE OUTCOMES:

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

CO1: Explain and analyze the radiation characteristics of dipole, loop antennas and antennas arrays

CO2: Describe the radiation characteristics & applications of special antennas and measurement procedure of antenna parameters

CO3: Explain the various modes of radio wave propagations

COURSE ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
CO3	H	L	L	-	-	-	-	-	-	-	-	-	H	M	L
18LPC 603	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L

L - Low, M - Moderate (Medium), H - High

18LPC604	COMPUTER SYSTEM ARCHITECTURE AND ORGANIZATION	SEMESTER VI

PRE-REQUISITES: NIL **Category: PC**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To learn the arithmetic unit, logic unit and the basics of pipelined execution.
- To understand parallelism and multi-core processors.
- To understand the memory hierarchies, cache memories and virtual memories.
- To learn the different ways of communication with I/O devices

UNIT- I :BASIC STRUCTURE OF A COMPUTER	**(9 Periods)**
Functional units-Basic operational concepts- Bus structures - Performance-Instructions: Language of the Computer –Operations, Operands – Instruction and instruction sequencing – Logical operations – decision making –Addressing and addressing modes	
UNIT- II :ARITHMETIC FOR COMPUTERS	**(9 Periods)**
Arithmetic and Logic Unit (ALU) -Addition and Subtraction – Signed and unsigned Multiplication – Division – Floating Point Representation – Floating Point addition and subtraction – Subword Parallelism.	
UNIT- III :PROCESSOR AND CONTROL UNIT	**(9 Periods)**
A Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Pipelining – Pipelined datapath and control – Handling Data Hazards & Control Hazards – Exceptions.	
UNIT- IV :PARALLELISM	**(9 Periods)**
Parallel processing challenges – Flynn‘s classification – SISD, MIMD, SIMD, SPMD and Vector Architectures – Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.	
UNIT- V :MEMORY& I/O SYSTEMS	**(9 Periods)**
Memory Hierarchy – memory technologies – cache memory – measuring and improving cache performance – virtual memory, TLB‘s – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits – USB.	

Contact periods:

Lecture: 45 periods **Tutorial: 0 periods** **Practical: 0 periods** **Total: 45 periods**

TEXT BOOKS:

*1. William Stallings, "**Computer Organization and Architecture – Designing for Performance**", Eighth Edition, Pearson Education, 2010*

*2. Carl Hamacher, ZvonkoVranesic, SafwatZaky, "**Computer Organization**", McGraw-Hill, Fifth Edition, Reprint 2012*

REFERENCE BOOKS:

*1. John P. Hayes, "**Computer Architecture and Organization**", Third Edition, Tata McGraw Hill, 2012*

*2. John L. Hennessey and David A. Patterson, "**Computer Architecture – A Quantitative Approach**", Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012*

*3. BehroozParahami, "**Computer Architecture**", Oxford University Press, EighthImpression, 2011.*

*4. David A. Patterson and John L. Hennessy, "**Computer Architecture-A Quantitative Approach**", Elsevier, a division of reed India Private Limited, Fifthedition, 2012.*

COURSE OUTCOMES:

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

CO1: Understand the basics structure of computers, operations and instructions.

CO2: Design arithmetic and logic unit and understand the various memory systems and I/O communication

CO3: Understand pipelined execution, parallel processing architectures and design control unit.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	H	-	-	-	-	-	-	-	-	-	-	H	-	-
CO2	H	M	-	M	-	-	-	-	-	-	-	-	M	H	-
CO3	H	-	M	-	-	-	M	-	-	-	-	-	H	-	-
18LPC 604	H	H	M	M	-	-	M	-	-	-	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LEE607	VLSI DESIGN LABORATORY	SEMESTER VI

PRE-REQUISITES: **Category: EEC**

* 18LPC304 DIGITAL SYSTEM DESIGN
* 18LPC406 ANALOG INTEGRATED CIRCUITS

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES

* To provide hands on design experience with professional design (EDA) platforms on the principles of VLSI circuit design in digital and analog domain.

PRACTICALS	**LIST OF EXPERIMENTS** 1. Design Entry, Simulation and Synthesis of Combinational Logic Circuits: full adder/full subtractor/4x1 Multiplexer and Demultiplexer/ALU. 2. Design Entry, Simulation and Synthesis of Sequential Logic Circuits: flip-flops/registers/counters/memory module. 3. Logic design and implementation using state machine. 4. UART/arbiter model. 5. Functional verification of the CMOS Inverter/Universal Logic gates through schematic entry 6. Functional verification of the Transmission Gate and Multiplexer using TG. 7. Calculate gain, bandwidth and CMRR of a differential amplifier through schematic entry. Tools & Hardware: EDA tool/FPGA Kits

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

REFERENCE BOOKS:

*1. Samir Palnitkar, "**Verilog HDL**", Pearson, 2nd Edition, 2010.*

*2. Williams, John Michael, "**Digital VLSI Design with Verilog, A Textbook from Silicon Valley Polytechnic Institute**," 2014 Springer.*

*3. "**Design of Analog CMOS Integrated Circuits**", by Behzad Razavi, McGraw-Hill, 2001.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: Simulate, Synthesize and Import Verilog HDL code for basic combinational and sequential circuits on FPGA boards.

CO2: An ability to analyze the differential amplifier and logic gates through schematic entry

CO3: Exposure to new technological and development on digital and analog CMOS VLSI design

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
CO2	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
CO3	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
18LEE 607	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-

L - Low, M - Moderate (Medium), H - High

18LEE608	EMBEDDED SYSTEMS LABORATORY	SEMESTER VI

PRE-REQUISITES: NIL **Category: EEC**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES

*This course enables the students to apply the theoretical concepts of ARM processor in real time.

PRACTICALS	**LIST OF EXPERIMENTS** The folLowing programs are to be implemented in ARM processor: 1. To configure and control General Purpose Input/output (GPIO) port pins. 2. Interfacing 8 Bit LED and Switch. 3. Implementation of Buzzer Interface on IDE environment. 4. Display a message in a 2 line x 16 Characters LCD display. 5. Time delay demonstration using built in Timer / Counter feature on IDE environment. 6. Simple interrupt handler and setting up a timer. 7. Interfacing ADC and DAC. 8. Generation of PWM. 9. Interfacing Matrix Keypad. 10. Implementation of Real Time clock. 11. Interfacing Temperature sensor. 12. Serial Data Transfer. Mini Project using ARM processor.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total:45 Periods**

REFERENCE BOOKS:

1.Andrew N.Sloss Dominic Symes Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Inc 2010.

2.JosephYiu ,"The Definitive Guide to the ARM Cortex-M" , Elsevier- Newness, 2014

COURSE OUTCOMES

Upon completion of the course, the students will have:

CO1: An ability to apply programming skills in ARM processor.
CO2: Practical exposure to various ports in ARM processor.
CO3: An ability to interface ADC and DAC.
CO4: Awareness to handle interrupts and timer in ARM processor.
CO5: An exposure to real time clock and serial data transfer.

COURSE ARTICULATION MATRIX:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
C01	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
CO2	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
C03	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
C04	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
C05	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-
18LEE 608	M	M	M	L	L	L	-	-	L	L	-	M	L	L	-

L - Low, M - Moderate (Medium), H - High

18LHS701	MANAGEMENT THEORY AND PRACTICE	SEMESTER VII

PRE-REQUISITES: NIL **Category: HS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To develop an understanding of the "relationship" aspect of management.
- To understand and develop the skills needed to face the difficulties in management of people and other resources.

UNIT I: BASICS OF MANAGEMENT THOUGHT	**(9 Periods)**
Evolution of Management –Definition- Levels-Principles – Difference with Administration –Roles of Managers – Social Responsibility of Business –External Environment of Business- Management Ethics.	
UNIT II: PLANNING	**(9 Periods)**
Nature-Purpose-Types-Steps-Management by Objectives-Strategic Planning and Process-Decision Making –Types of decisions- Approaches to decision-Making under uncertainty.	
UNIT III: ORGANIZING	**(9 Periods)**
Formal, Informal Organization-Span of Management- Departmentation- Line, Staff Authority, Decentralization and Delegation of authority – Effective organization and Organization culture.	
UNIT IV: STAFFING AND LEADING	**(9 Periods)**
System approach to staffing- Performance appraisal process and career strategy formulation, Leadership Theories, Theories of motivation, Communication – Process, Barriers, Guidelines for effective Communication- Electronic media in communication.	
UNIT V: CONTROLLING	**(9 Periods)**
Process, feedback loop of Management Control, Requirements for effective control- Control Techniques – Operation Research for controlling, Overall and preventive control.	

Contact Periods:

Lecture:45 Periods Tutorial: 0 Periods Practical:0 Periods Total:45 Periods

TEXT BOOKS:

1. *Harold Koontz, Weihrich, " **Essential of Management**", Tata McGraw Hill New Delhi 2010.*
2. *Tripathy P.C and Reddy P.N "**Principles of Management**", Tata McGraw Hill 2010.*

REFERENCE BOOKS:

1. *Joseph Massie, "**Essentials of Management**", Prentice Hall of India, New Delhi 2010.*
2. *Prasad, L.M., "**Principles and Practice of Management**", Sultan Chand and Sons, New Delhi 2010.*

COURSE OUTCOMES:

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

CO1: The students would be equipped with the skills to understand human behaviour.

CO2: The students would be able to successfully handle problems of resources management.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	H	-	H	-	H	-	-	-
CO2	-	-	-	-	-	H	-	-	H	H	-	-	-	-	-
18LHS 701	-	-	-	-	-	H	-	H	H	H	-	H	-	-	-

L - Low, M - Moderate (Medium), H - High

18LPC702	MICROWAVE ENGINEERING	SEMESTER VII

PRE-REQUISITES: 18LES402 ELECTROMAGNETIC WAVES **Category: PC**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the microwave generation, behavior of microwave devices
- To study microwave measurement procedures
- To acquire knowledge on RF amplifiers and matching networks

UNIT I: MICROWAVE NETWORK ANALYSIS AND RF BEHAVIOUR	**(9 Periods)**
Scattering (S) Matrix: Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network – Transmission (ABCD) matrix - Significance and issues of RF design - RF behavior of Resistors, Capacitors and Inductors- design of high frequency passive components.	
UNIT II: MICROWAVE GENERATION	**(9 Periods)**
High frequency effects in vacuum Tubes - Theory and application of Two cavity Klystron Amplifier- velocity modulation – bunching process - Reflex Klystron oscillator - Traveling wave tube amplifier - Magnetron oscillator: Cylindrical, Linear, Coaxial& Voltage tunable Magnetrons – Gunn effect diode – Gunn oscillation modes	
UNIT III: PASSIVE AND ACTIVE MICROWAVE DEVICES	**(9 Periods)**
Circulator – Isolator- T-junction power divider -Magic Tee –Rate-race circuits- Directional couplers –Wilkinson power divider - Hybrid Junctions -Ferrite phase shifter – Tunnel diode -IMPATT diode TRAPATT diode -Varactor diode- S parameters of microwave components- Introduction to MIC	
UNIT IV: RF AMPLIFIERS AND MATCHING NETWORKS	**(9 Periods)**
Micro strip Transmission line - Smith Chart - Impedance transformation - Admittance transformation - Impedance matching using discrete components - Two component matching Networks - Micro strip Line Matching Networks- Characteristics of Amplifiers - Amplifier power relations - Stability considerations - Stabilization Methods - Noise Figure - Constant VSWR – Broadband Amplifiers - High power amplifiers	
UNIT V: MICROWAVE MEASUREMENTS	**(9 Periods)**
Operation and application of VSWR meter - Power meter - Spectrum analyzer - Network analyzer - Measurement of Impedance – Frequency – Power – Reflection coefficient -VSWR - Q-factor - Dielectric constant - S-parameters.	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. David M. Pozar, "**Microwave Engineering**", Wiley India (P) Ltd, New Delhi, 4th edition, 2012.*

*2. Samuel Y. Liao, "**Microwave Devices and Circuits**", Prentice Hall of International Ltd, 4th Edition, 2009.*

*3. Reinhold Ludwig and Gene Bogdanov, "**RF Circuit Design: Theory and Applications**", Pearson Education Inc., 2011.*

REFERENCE BOOKS:

*1. Annapurna Das and Sisir K Das, "**Microwave Engineering**", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017.*

*2. Mathew M Radmanesh, "**RF and Microwave Electronics**", Prentice Hall, 2000*

*3. Thomas H Lee, "**Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits**", Cambridge University Press, 2004.*

*4. Robert E Colin, "**Foundations for Microwave Engineering**", John Wiley & Sons, 2010*

COURSE OUTCOMES:

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

CO1: Explain the methods of microwave generation and formulate S matrix of microwave components

CO2: Describe the operation of active microwave devices, RF amplifiers and obtain discrete component impedance matching networks

CO3: Explain the operation of microwave test equipment's and procedure of microwave measurements

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
CO3	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
18LPC 702	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L

L - Low, M - Moderate (Medium), H - High

18LPC707	MICROWAVE AND ANTENNA LABORATORY	SEMESTER VII

PRE-REQUISITES: NIL **Category: PC**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES

- To learn Gunn diode characteristics and Mode characteristics of Klystron tube.
- To study the various parameters of Microwave components and VSWR measurement.
- To learn Spectrum Analyzer measurement
- To simulate microstrip antenna radiation characteristics.
- To learn characterization using Network analyzer

PRACTICALS	**List of Experiments:** 1. Study of microwave components. 2. Determination of Gunn Diode Characteristics. Determination of Mode Characteristics of a Reflex Klystron. 4. Measurement of VSWR and Reflection coefficient. 5. Measurement of frequency using slotted section. 6. Characteristics of isolator and circulator. 7. Characteristics of directional couplers. 8. Characteristics of magic tee. Frequency response of RF filters using spectrum analyzer. 10. Characterization of RF filters using network analyzer. 11. Measurement of radiation pattern and gain of an antenna. 12. Characteristics of microstrip components. Design and Simulation of microstrip antennas using EM Solver tool. Characterization of microstrip antennas using Vector Network Analyzer Study the performance of RF transmitter and RF receiver link

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45Periods** **Total: 45Periods**

REFERENCE BOOKS:

*1. David M..Pozar, "**Microwave Engineering",** John Wiley & Sons, 4th edition, 2012.*

*2. Annapurna Das and Sisir K Das, "**Microwave Engineering**", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017.*

*3. John D Kraus, Ronald J Marhefka. "**Antennas and Wave Propagation**", 4th edition,Tata McGrawHill, 2010.*

COURSE OUTCOMES

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

CO1: Ability to measure GUNN diode and Klystron Mode characteristics.

CO2: Ability to measure parameters of Microwave components.

CO3: Ability to characterize RF Filters and simulate & test microstrip antenna characteristics using Spectrum and Network analyzers

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	-	-	-	-	-	-	-	M	L	-	L	H	L	L
CO2	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L
CO3	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L
18LPC 707	H	-	M	-	M	-	-	-	M	L	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LEE708	MINI PROJECT	SEMESTER VII

PRE-REQUISITES: NIL **Category: EEC**

L	T	P	C
0	0	8	4

COURSE OBJECTIVES:

- To expose students to take up real time problems and challenges.
- To develop confidence to take up a project independently.
- To develop understanding of technical dissertation presentation and writing.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 120 Periods** **Total: 120 Periods**

COURSE OUTCOMES

Upon completion of the course, the students will have:

CO1: An exposure to take up real time problems and challenges.

CO2: Confidence to take up a project independently.

CO3: An understanding of technical dissertation presentation and writing.

COURSE ARTICULATION MATRIX:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	L	L	-	M	M	L	M	L	L	M	M	M	L	-	H
CO2	-	H	H	L	H	M	L	M	M	-	M	M	L	L	H
CO3	M	M	M	L	H	M	-	M	M	M	M	M	L	L	H
18LEE 708	M	H	H	L	H	M	M	M	M	M	M	M	L	L	H

L - Low, M - Moderate (Medium), H - High

18LVL709	VIRTUAL LABORATORY ON DIGITAL VLSI DESIGN	SEMESTER VII

PRE-REQUISITES:

- 18LPC304 – DIGITAL SYSTEM DESIGN
- 18LPC602 – VLSI DESIGN

Category: EEC

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

* To provide hands on design experience with virtual professional design (EDA) platforms on the principles of digital VLSI circuit design.

PRACTICALS

LIST OF EXPERIMENTS:

Characterization of the following digital VLSI circuits.

1. MOSFET/ CMOS Inverter.
2. Logic Gates.
3. Ring Oscillator.
4. 4x1 Multiplexer.
5. Latches.
6. Registers.

Tools and Hardware : EDA Tool / Virtual simulator.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 15 Periods** **Total: 15 Periods**

Reference Books :

1. J.M. Rabaey, A.Chandrakasan and B.Nikolic, Digital Integrated Circuits – A Design Perspective, 2nd ed., PHI, 2003
2. Weste, CMOS VLSI Design: A Circuits and Systems Perspective, 3rd edition, Pearson Education India, 2007
3. David A. Hodges, Horace G. Jackson, Resve Saleh, Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology, 3rd international edition, McGraw Hill, 2004
4. Kang and Leblevici, CMOS Digital Integrated Circuits Analysis and design, 3rd ed., McGraw Hill 2003.
5. J.P. Uyemura, Introduction to VLSI Circuits and systems, John wiley & sons (Asia) Pte Ltd, 2002.
6. W. Wolf, Modern VLSI Design – system on chip design, 3ed, pearson Education, 2004.

COURSE OUTCOMES

Upon completion of the course, the students will have:

CO1: An ability to simulate and analyze the basic digital VLSI circuits.

CO2: Exposure to new technological and development on digital VLSI design.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	H	H	H	M	-	-	-	-	-	M	-	H	H	M	-
CO2	H	H	H	M	-	-	-	-	-	M	-	H	H	M	-
18LVL 709	H	H	H	M	-	-	-	-	-	M	-	H	H	M	-

L - Low, M - Moderate (Medium), H – High

18LEE803	PROJECT WORK	SEMESTER VIII

L	T	P	C
0	0	16	8

Category: EEC
PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To expose students to take up real time problems and challenges.
- To develop confidence to take up a project independently.
- To develop understanding of technical dissertation presentation and writing.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 240 Periods Total: 240 Periods

COURSE OUTCOMES

Upon completion of the course, the students will have:
CO1: An exposure to take up real time problems and challenges.
CO2: Confidence to take up a project independently.
CO3: An understanding of technical dissertation presentation and writing.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PS0 3
CO1	L	L	-	M	M	L	M	L	L	M	M	M	L	-	H
CO2	-	H	H	L	H	M	L	M	M	-	M	M	L	L	H
CO3	M	M	M	L	H	M	-	M	M	M	M	M	L	L	H
18LEE 803	M	H	H	L	H	M	M	M	M	M	M	M	L	L	H

L - Low, M - Moderate (Medium), H - High

18LPE$01	INFORMATION THEORY AND CODING

PRE-REQUISITES: NIL **Category: PE**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To study the several source coding techniques.
- To study the channel coding theorem & various codes.
- To study about Block control coding.

UNIT I : INFORMATION THEORY	**(9 Periods)**
Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memoryless channels – BSC, BEC – Channel capacity, Shannon limit.	
UNIT II : SOURCE CODING: TEXT, AUDIO AND SPEECH	**(9 Periods)**
Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding.	
UNIT III: COMPRESSING TECHNIQUES	**(9 Periods)**
Principles – Text compression – Static Huffman Coding – Dynamic Huffman coding – Arithmetic coding – Image Compression – Graphics Interchange format – Tagged Image File Format – Digitized documents – Introduction to JPEG standards.	
UNIT IV: AUDIO AND VIDEO CODING	**(9 Periods)**
Linear Predictive coding – code excited LPC – Perceptual coding, MPEG audio coders – Dolby audio coders – Video compression – Principles – Introduction to H.261 & MPEG Video standards.	
UNIT-V: CRYPTOGRAPHY	**(9 Periods)**
Cryptography: Encryption; Decryption; Cryptogram (cipher text); Concept of cipher; Cryptanalysis; Keys: Single key (Secret key); Cryptography; two-key (Public key) cryptography; Single key cryptography; Ciphers; Block Cipher code; Stream ciphers; Requirements for secrecy; The data Encryption Standard; Public Key Cryptography; Diffie-Hellmann public key distribution; The Rivest - Shamin Adelman(R-S-A) system for public key cryptography; Digital Signature.	

Contact periods:
Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1. R Bose, "**Information Theory, Coding and Cryptography**", TMH 2007*
*2. Fred Hassall, "**Multimedia Communications: Applications, Networks, Protocols and Standards**", Pearson Education Asia, 2002*

REFERENCE BOOKS:

*1. K Sayood, "**Introduction to Data Compression**" 3/e, Elsevier 2006*
*2. S Gravano, "**Introduction to Error Control Codes**", Oxford University Press 2007*
*3. Amitabha Bhattacharya, "**Digital Communication**", TMH 2006*
4. Local Area Network by G. Keiser, TMH (for Unit – V)

COURSE OUTCOMES:

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

CO1: Apply the fundamentals of information theory to source coding
CO2: Understand principle of compression techniques, audio and video coder
CO3: Understand the fundamentals of cryptography

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPE $01	M	M	M									L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPE$02	SPEECH SIGNAL PROCESSING

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To have in-depth knowledge on basic concepts and speech Analysis.
- To analyze the quality and properties of speech signal.
- To model speech signals
- To have in-depth knowledge on speech recognition and speech synthesis

UNIT I: SPEECH FUNDAMENTALS	**(9 Periods)**
Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.	
UNIT II: SPEECH ANALYSIS	**(9 Periods)**
Speech Analysis: 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, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.	
UNIT III: SPEECH MODELING	**(9 Periods)**
Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.	
UNIT IV: SPEECH RECOGNITION	**(9 Periods)**
Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.	
UNIT-V: SPEECH SYNTHESIS	**(9 Periods)**
Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.	

Contact periods:

Lecture:45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

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TEXT BOOKS:

1. *Lawrence Rabiner and Biing-Hwang Juang, "**Fundamentals of Speech Recognition**", Pearson Education, 2003.*
2. *Daniel Jurafsky and James H Martin, "**Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition**", Pearson*

Education.

REFERENCE BOOKS:

*1.Steven W. Smith, "**The Scientist and Engineer's Guide to Digital Signal Processing**", California Technical Publishing.*

*2.Thomas F Quatieri, "**Discrete-Time Speech Signal Processing – Principles and Practice**", Pearson Education.*

*3.Claudio Becchetti and Lucio Prina Ricotti, "**Speech Recognition**", John Wiley and Sons, 1999.*

*4.Ben gold and Nelson Morgan, "**Speech and audio signal processing**", processing and perception of speech and music, Wiley- India Edition, 2006 Edition.*

*5.Frederick Jelinek, "**Statistical Methods of Speech Recognition**", MIT Press.*

COURSE OUTCOMES:

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

CO1: To in-depth knowledge on basic concepts and speech Analysis.

CO2: To analyze the quality and properties of speech signal.

CO3: To model speech signals

CO4: To have in-depth knowledge on speech recognition and speech synthesis

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	H	M	-	-	H	-	-	-	-	H	H	M	-
CO2	L	M	L	M	-	-	L	-	-	-	-	H	H	M	-
CO3	L	L	H	M	-	-	H	-	-	-	-	H	M	H	-
CO4	M	M	L	M	-	-	M	-	-	-	-	H	H	M	-
18LPE $02	M	M	H	M	-	-	H	-	-	-	-	H	H	M	-

L - Low, M - Moderate (Medium), H - High

18LPE$03	INTRODUCTION TO MEMS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn the fabrication process in MEMS and acquire knowledge on various sensors and actuators

UNIT I: INTRODUCTION	**(9 Periods)**
History of Micro Electro Mechanical Systems (MEMS) – MEMS Materials: Silicon and other materials - Intrinsic Characteristics of MEMS – Energy Domains and Transducers– Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Stress and strain analysis – Flexural beam bending- Torsional deflection.	
UNIT II: MEMS FABRICATION	**(9 Periods)**
MEMS fabrication processes: Review of IC fabrication process. Micromachining: Bulk Micromachining - Dry and Wet etching - Surface micromachining - Deposition, Evaporation, Sputtering, Epitaxial growth - Deep Reaction ion etching - Advanced Lithography - LIGA process - Multi User MEMS Process.	
UNIT III: ELECTROSTATIC SENSORS	**(9 Periods)**
Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Magnetic Actuators – Micromagnetic components – Actuation using Shape Memory Alloys.	
UNIT IV: MAGNETOSTATIC SENSORS	**(9 Periods)**
Piezoresistive sensors – Piezoresistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and FLow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and FLow sensors.	
UNIT-V: APPLICATION CASE STUDIES	**(9 Periods)**
Application case studies: MEMS Scanners and Retinal Scanning Displays (RSD), Grating Light Valve (GLV), Digital Micromirror Devices (DMD), Optical switching, Capacitive Micromachined Ultrasonic Transducers (CMUT), Air bag system, Micromotors, Scanning Probe Microscopy.	

Contact periods:

Lecture:45 Periods Tutorial:0 Periods Practical:0 Periods Total:45 Periods

TEXT BOOKS:

*1. Chang Liu, "**Foundations of MEMS**", Pearson Education Inc.,2nd edition 2006.*

*2. Stephen D Senturia, "**Microsystem Design**", Springer Publication,1st edition 2000*

REFERENCE BOOKS:

*1. Julian W.Gardner, Vijay K.Varadan, Osama O. AwadelKarim, "**Micro sensors MEMS and Smart Devices**", John Wiby& sons Ltd., 1st edition 2001.*

*2. Mohamed Gad – el – Hak, "**MEMS Handbook**", CRC Press, 2nd edition 2002.*

*3. Rai - Choudhury P. "**MEMS and MOEMS Technology and Applications**", PHI Learning Private Limited, 1st edition 2009*

*4. Sabrie Solomon, "**Sensors Handbook**," 2nd edition McGraw Hill, 1998.*

*5. Marc F Madou, "**Fundamentals of Micro Fabrication**", CRC Press, 2nd Edition, 2002.*

*6. Tai Ran Hsu, "**MEMS & Micro systems Design and Manufacture**" 2nd edition Tata McGraw Hill, New Delhi, 2002.*

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Knowledge on materials used in MEMS and MEMS fabrication process

CO2: In-depth knowledge on different types of sensors and actuators.

CO3: Exposure to applications and case studies of MEMS.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	L	-	-	-	-	-	L	-	-	-	-	-	H	-	-
CO2	H	-	L	-	-	-	-	-	-	-	-	-	L	M	-
CO3	L	-	L	-	-	-	L	-	-	M	-	-	L	H	-
18LPE $03	H	-	L	-	-	-	L	-	-	M	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LPE$04	POWER ELECTRONICS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To get an overview of different types of power semiconductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers
- To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To study the operation of AC voltage controller and various configurations.

UNIT- I : POWER ELECTRONICS	**(9 Periods)**
Study of switching devices, Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT-Static and Dynamic characteristics - Triggering and commutation circuit for SCR- Design of Driver and snubber circuit. Study of switching devices, Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT-Static and Dynamic characteristics - Triggering and commutation circuit for SCR- Design of Driver and snubber circuit.	
UNIT- II : PHASE-CONTROLLED CONVERTERS	**(9 Periods)**
2-pulse, 3-pulse and 6-pulse converters– performance parameters –Effect of source inductance—Gate Circuit Schemes for Phase Control–Dual converters.	
UNIT- III : DC TO DC CONVERTER	**(9 Periods)**
Step-down and step-up chopper - control strategy – Forced commutated chopper – Voltage commutated, Current commutated, Load commutated, Switched mode regulators - Buck, boost, buck- boost converter, Introduction to Resonant Converters.	
UNIT- IV : INVERTERS	**(9 Periods)**
Single phase and three phase voltage source inverters (both 1200 mode and 1800 mode) – Voltage & harmonic control - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM - multiple PWM – Introduction to space vector modulation – Current source inverter.	
UNIT- V : AC TO AC CONVERTERS	**(9 Periods)**
Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control – Multistage sequence control -single phase and three phase cyclo converters – Introduction to Matrix converters.	

Contact periods:

Lecture: 45 periods **Tutorial: 0 periods** **Practical: 0 periods** **Total: 45 periods**

TEXT BOOKS:

1. *M.H.Rashid, "**Power Electronics: Circuits, Devices and Applications"**, Pearson Education, PHI Third Edition, New Delhi, 2004.*
2. *P.S. Bimbra, "**Power Electronics**," Khanna Publishers, third Edition, 2003.*

3. *L. Umanand, "**Power Electronics: Essentials and Applications**", Wiley, 2010.*

REFERENCE BOOKS:

*1. Joseph Vithayathil, "**Power Electronics, Principles and Applications"**, McGraw Hill Series, 6th Reprint, 2013.*

*2. Ashfaq Ahmed, "**Power Electronics for Technology**", Pearson Education, Indian reprint, 2003.*

*3. Philip T. Krein, "**Elements of Power Electronics**" Oxford University Press, 2004 Edition.*

*4. Ned Mohan Tore. M. Undel and, William. P. Robbins, "**Power Electronics: Converters, Applications and Design**", John Wiley and sons, third edition, 2003.*

*5. Daniel.W.Hart, "**Power Electronics**", Indian Edition, Mc Graw Hill, 3rd Print, 2013.*

COURSE OUTCOMES:

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

CO1: To understand types of power electronics devices and controlled rectifiers.

CO2: To understand switching techniques, topologies of DC-DC switching regulators and AC voltage regulators.

CO3: To understand different modulation techniques for modulated receivers and harmonic reduction methods

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	H	M	-	-	-	-	-	-	-	-	-	H	-	-
CO2	-	M	H	L	-	M	-	-	-	-	-	-	H	-	-
CO3	H	M	-	L	-	-	-	-	-	-	-	-	H	-	-
18LPE $04	H	H	H	L	-	M	-	-	-	-	-	-	H	-	-

L - Low, M - Moderate (Medium), H - High

18LPE$05	NANO ELECTRONICS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates.
- To explore the basics of nanomaterial synthesis and characterization.
- To introduce the applications of nanotechnology.

UNIT- I : INTRODUCTION TO NANO TECHNOLOGY	**(9 Periods)**
Microelectronics towards biomolecule electronics - Particles and waves - Wave-particle duality - Wave mechanics - Schrödinger wave equation - Wave mechanics of particles: Atoms and atomic orbitals - Materials for nanoelectronics- Semiconductors- Crystal lattices: Bonding in crystals- Electron energy bands- Semiconductor heterostructures- Lattice-matched and pseudomorphic heterostructures - Inorganic-organic heterostructures - Carbon nanomaterials: nanotubes and fullerenes.	
UNIT- II : FABRICATION AND MEASUREMENT TECHNIQUES	**(9 Periods)**
Growth, fabrication, and measurement techniques for nanostructures- Bulk crystal and heterostructure growth- Nanolithography, etching, and other means for fabrication of nanostructures and nano devices- Techniques for characterization of nanostructures- Spontaneous formation and ordering of nanostructures- Clusters and nanocrystals- Methods of nanotube growth- Chemical and biological methods for nanoscale fabrication- Fabrication of nano-electromechanical systems.	
UNIT- III : PROPERTIES	**(9 Periods)**
Dielectrics-Ferroelectrics-Electronic Properties and Quantum Effects-Magneto electronics – Magnetism and Magneto transport in Layered Structures-Organic Molecules – Electronic Structures, Properties, and Reactions-Neurons – The Molecular Basis of their Electrical Excitability-Circuit and System Design-Analysis by Diffraction and Fluorescence Methods-Scanning Probe Techniques.	
UNIT- IV : NANO STRUCTURE DEVICES	**(9 Periods)**
Electron transport in semiconductors and nanostructures- Time and length scales of the electrons in solids- Statistics of the electrons in solids and nanostructures- Density of states of electrons in nanostructures- Electron transport in nanostructures-Electrons in traditional Low-dimensional structures- Electrons in quantum wells- Electrons in quantum wires- Electrons in quantum dots- Nanostructure devices- Resonant-tunneling diodes- Field-effect transistors- Single-electron-transfer devices- Potential-effect transistors- Light-emitting diodes and lasers- Nano-electromechanical system devices- Quantum-dot cellular automata	
UNIT- V : LOGIC DEVICES AND APPLICATIONS	**(9 Periods)**
Logic Devices-Silicon MOSFETs-Ferroelectric Field Effect Transistors-Quantum Transport Devices Based on Resonant Tunneling-Single-Electron Devices for Logic Applications-Superconductor Digital Electronics-Quantum Computing Using Superconductors-Carbon Nanotubes for Data Processing-Molecular Electronics	

Contact periods:

Lecture: 45 periods **Tutorial: 0 periods** **Practical: 0 periods** **Total: 45 periods**

TEXT BOOKS:

1. *Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio,* ***"Introduction to Nanoelectronics: Science, Nano technology, Engineering, and Applications"****, Cambridge University Press 2011.*
2. *Supriyo Datta,* ***"Lessons from Nano electronics: A New Perspective on Transport"****, World Scientific 2012.*

REFERENCE BOOKS:

1. *George W. Hanson,* ***"Fundamentals of Nano electronics"****, Pearson 2009.*
2. *Korkin, Anatoli; Rosei, Federico (Eds.),* ***"Nano electronics and Photonics"****, Springer 2008.*
3. *Mircea Dragoman, Daniela Dragoman,* ***"Nano electronics: principles and devices"****, CRC Press 2006*
4. *Karl Goser, Peter Glösekötter, Jan Dienstuhl,* ***"Nano electronics and Nano systems: From Transistors to Molecular and Quantum Devices"****, Springer 2004.*

COURSE OUTCOMES:

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

CO1: To understand the basics of nanotechnology and different fabrications methods.

CO2: To understand the behavior of nanomaterials and related structures

CO3: To analyze and design nanostructure devices and logic circuits

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	-	M	-		M	-	-	-	-	-	H	-	-
CO2	-	-	H	-	-		M	M	-	-	-	-	H	-	-
CO3		M	M	H	-	L	-	-	-	-	-	-	M	H	-
18LPE $05	H	M	H	H	-	L	M	M	-	-	-	-	H	H	-

L - Low, M - Moderate (Medium), H - High

18LPE$06	SOFT COMPUTING

PRE-REQUISITES: NIL **Category: PE**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To learn the basic concepts of Soft Computing
- To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems.
- To apply soft computing techniques to solve problems.

UNIT- I : INTRODUCTION TO SOFT COMPUTING	**(9 Periods)**
Introduction-Artificial Intelligence-Artificial Neural Networks-Fuzzy Systems-Genetic Algorithm and Evolutionary Programming-Swarm Intelligent Systems-Classification of ANNs-McCulloch and Pitts Neuron Model-Learning Rules: Hebbian and Delta- Perceptron Network-Adaline Network-Madaline Network.	
UNIT- II : ARTIFICIAL NEURAL NETWORKS	**(9 Periods)**
Back propagation Neural Networks – Kohonen Neural Network -Learning Vector Quantization -Hamming Neural Network – Hopfield Neural Network- Bi-directional Associative Memory -Adaptive Resonance Theory Neural Networks- Support Vector Machines – Spike Neuron Models.	
UNIT- III : FUZZY SYSTEMS	**(9 Periods)**
Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets – Classical Relations and Fuzzy Relations -Membership Functions -Defuzzification – Fuzzy Arithmetic and Fuzzy Measures -Fuzzy Rule Base and Approximate Reasoning – Introduction to Fuzzy Decision Making.	
UNIT- IV : GENETIC ALGORITHMS	**(9 Periods)**
Basic Concepts- Working Principles -Encoding- Fitness Function – Reproduction -Inheritance Operators – Cross Over – Inversion and Deletion -Mutation Operator – Bit-wise Operators -Convergence of Genetic Algorithm.	
UNIT- V : HYBRID SYSTEMS	**(9 Periods)**
Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic -GA Based Weight Determination – LR-Type Fuzzy Numbers – Fuzzy Neuron – Fuzzy BP Architecture – Learning in Fuzzy BP-Inference by Fuzzy BP – Fuzzy ArtMap: A Brief Introduction – Soft Computing Tools – GA in Fuzzy Logic Controller Design – Fuzzy Logic Controller	

Contact periods:
Lecture: 45 periods **Tutorial: 0 periods** **Practical: 0 periods** **Total: 45 periods**

TEXT BOOKS:

1. *N.P.Padhy, S.P.Simon, "**Soft Computing with MATLAB Programming**", Oxford University Press, 2015.*
2. *S.N.Sivanandam, S.N.Deepa, "**Principles of Soft Computing**", Wiley India Pvt. Ltd., 2nd Edition, 2011.*

3. *S.Rajasekaran, G.A.Vijayalakshmi Pai, "**Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications**", PHI Learning Pvt. Ltd., 2017.*

REFERENCE BOOKS:

1. *Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, — "**Neuro-Fuzzy and Soft Computing"**, Prentice-Hall of India, 2002.*
2. *Kwang H.Lee, — "**First course on Fuzzy Theory and Applications"**, Springer, 2005.*
3. *George J. Klir and Bo Yuan, — "**Fuzzy Sets and Fuzzy Logic-Theory and Applications"**, Prentice Hall, 1996.*
4. *James A. Freeman and David M. Skapura, — "**Neural Networks Algorithms, Applications, and Programming Techniques"**, Addison Wesley, 2003.*

COURSE OUTCOMES:

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

CO1: Apply suitable soft computing techniques for various applications.

CO2: Integrate various soft computing techniques for complex problems.

CO3: Understand genetic algorithms and hybrid systems.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	-	H	-	-	M	-	L	-	-	-	-	H	-	-
CO2	-	-	-	H	M	-	-	-	-	-	-	-	H	-	-
CO3	M	H	-	H	-	L	-	-	-	-	-	-	H	-	-
18LPE $06	M	H	H	H	M	M	-	L	-	-	-	-	H	-	-

L - Low, M - Moderate (Medium), H - High

18LPE$07	AUTOMOTIVE ELECTRONICS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To acquire in-depth knowledge on the basic electrical and electronic components used in an automotive systems.
- To apply knowledge of an embedded system in automotive electronic systems.
- To learn the various vehicle communication protocols.

UNIT- I : ELECTRONICS IN AUTOMOTIVE SYSTEMS	**(9 Periods)**
Overview of Automotive Mechanical systems- Need for Automotive Electronics System - Performance (Speed, Power and Torque) - Control (Emission, Fuel Economy, Drivability and Safety) and Legislation (Environmental legislation for pollution and safety norms) - Overview of vehicle electronic systems - Basic electrical components and their operation in an automobile- Power train subsystem(Starting systems, Charging systems, Ignition systems, Electronic fuel control) - Chassis subsystem(ABS,TCS and ESP) - Comfort and safety subsystems (Night vision, airbags, Seatbelt Tensioners, Cruise Control- Lane-departure-warning, Parking)	
UNIT- II : FABRICATION AND MEASUREMENT TECHNIQUES	**(9 Periods)**
Hardware module - Introduction to an embedded board -components - Software Module: IDE - Getting started: Creating new project, creating new files, adding files to project, compile, build, debug and simulation of a project.	
UNIT- III : EMBEDDED SYSTEM PROGRAMMING AND DEBUGGING	**(9 Periods)**
Embedded System Programming - Up-loaders- ISP - ROM Emulators - In-Circuit Emulators - Debug Interfaces: BDM and JTAG.	
UNIT- IV: EMBEDDED SYSTEM IN AUTOMOTIVE APPLICATIONS	**(9 Periods)**
Engine management systems - Gasoline/ Diesel systems, various sensors used in system - Electronic transmission control - Vehicle safety system - Electronic control of braking and traction - Body electronics - Infotainment systems - Navigation systems - System level tests - Software calibration using engine and vehicle dynamometers - Environmental tests for Electronic Control Unit - Application Control Unit - Application of Control elements and control methodology in Automotive System.	
UNIT- V : EMBEDDED SYSTEM COMMUNICATION PROTOCOLS	**(9 Periods)**
Introduction to control networking - Communication protocols in embedded systems - SPI, I 2C, USB - Vehicle communication protocols - Introduction to CAN, LIN, FLEXRAY, MOST, KWP2000.	

Contact Periods:

Lecture: 45 Periods **Tutorial:0 Periods** **Practical: 0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1. Denton.T, "**Automobile Electrical and Electronic Systems**", Edward Arnold Publishers, 4th Edition 2012.*
*2. Nicholas Navit, "**Automotive Embedded System Handbook**", CRC press, 2009.*

REFERENCE BOOKS:

*1.Robert Bosch GmbH, "**Automotive Handbook**", John Wiley & Sons, 6th Edition, 2004.*
*2.Knowles.D, "**Automotive Electronic and Computer Controlled Ignition Systems**", Prentice Hall,1998*
*3.William B. Ribbens, "**Learning Automotive Electronics**", Newnes Publishing, 6th Edition 2003*
*4.Joerg Schaeuffele, Thomas Zurawka - "**Automotive Software Engineering- Principles, Processes, Methods and Tools**", SAE Publications,2005*

COURSE OUTCOMES

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

CO1: An in-depth knowledge of the basic electrical and electronic components used in an automotive systems.
CO2: An ability to do projects using Embedded hardware and software.
CO3: An in- depth knowledge on programming and debugging skills.
CO4: An ability to apply knowledge of an embedded system in automotive electronic Systems.
CO5: Knowledge on various Embedded system communication protocols.
CO6: Knowledge on various vehicle communication protocols.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	L	-	L	L	L	-	-	L	-	-	L	M	M	-
CO2	M	M	M	L	H	L	-	-	-	-	-	L	M	H	-
CO3	M	M	H	M	M	L	L	-	-	L	L	L	M	M	-
CO4	M	H	-	M	H	L	-	-	-	-	-	L	M	H	-
CO5	M	H	H	M	H	L	L	-	L	L	L	L	L	M	-
CO6	M	L	-	L	L	L	-	-	L	-	-	L	M	M	-
18LPE $07	M	H	H	M	H	L	L	-	L	L	L	L	M	M	-

L - Low, M - Moderate (Medium), H - High

18LPE$08	MIXED SIGNAL DESIGN

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To gain a basic knowledge of sampling circuits and Sample & Hold architectures.
- To acquire in-depth knowledge in digital to analog and analog to digital architectures.
- To learn about CMOS power amplifiers.

UNIT I-SAMPLE-AND-HOLD ARCHITECTURES	**(9 Periods)**
Introduction to Data conversion and Processing- Sampling Switches-MOS, Diode Switches-Improvements in MOS Switch Performance-Conventional Open-Loop and Closed-Loop Architecture, Open-Loop Architecture with Miller Capacitance, Multiplexed-Input Architectures, Recycling Architecture, Switched-Capacitor Architecture, Current-Mode Architecture.	
UNIT- II : DIGITAL-TO-ANALOG CONVERTER ARCHITECTURES	**(9 Periods)**
Basic principles-General Considerations-Performance Metrics-Reference Multiplication and Division-Switching and Logical Functions in DACs-Resistor-Ladder DAC Architectures, Current-Steering Architectures.	
UNIT- III : ANALOG-TO-DIGITAL CONVERTER ARCHITECTURES	**(9 Periods)**
General Considerations- Performance Metrics- Flash Architectures, Two-Step Architectures, Interpolative and Folding Architectures, Pipelined Architectures, Successive Approximation Architectures, Interleaved Architectures.	
UNIT- IV : BUILDING BLOCKS OF DATA CONVERSION SYSTEMS	**(9 Periods)**
Amplifiers- Open-Loop Amplifiers, Closed-Loop Amplifiers, Operational Amplifiers, Gain Boosting Techniques, Common-Mode Feedback. Comparators- Bipolar Comparators, CMOS Comparators, BiCMOS Comparators.	
UNIT- V : PRECISION TECHNIQUES	**(9 Periods)**
Comparator Offset Cancellation- Input, Output and multistage Offset Storage, Comparators Using Offset-Cancelled Latches- Op Amp Offset Cancellation- Calibration Techniques- DAC and ADC Calibration Techniques.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Behzad Razavi, "**Principles of Data Conversion System Design**", John Wiley & Sons, 2011.*
2. *Sundaram Natarajan, "**Microelectronics Analysis & design"**, McGraw Hill 2006*

REFERENCE BOOKS:

1. *R. J Baker, "**CMOS Mixed Signal Circuit Design**", Wiley Interscience, 2nd Edition, 2009.*
2. *B.Razavi, "**Design of Analog CMOS Integrated Circuits**", McGraw Hill, 2005.*
3. *David A. Johns and Ken Martin, "**Analog Integrated Circuit Design**", Wiley India, 2008.*

COURSE OUTCOMES:

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

CO 1: A basic knowledge of sampling circuits and Sample & Hold architectures

CO 2: In-depth knowledge of digital to analog and analog to digital architectures

CO 3: Knowledge about Data conversion and precision techniques

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	L	M	M	M	-	M	L	L	M	M	H	L	L	M
CO2	H	-	M	-	-	-	-	-	-	-	-	-	L	L	M
CO3	H	H	L	-	M	-	L	-	L	-	-	-	L	L	M
18LPE $08	H	H	M	M	M	-	M	L	L	M	M	H	L	L	M

L - Low, M - Moderate (Medium), H - High

18LPE$09	EMBEDDED SYSTEMS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn the architecture and programming of ARM processor.
- To become familiar with the embedded computing platform design and analysis.
- To get thorough knowledge in interfacing concepts.
- To design an embedded system and to develop programs.

UNIT I INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS	**(9 Periods)**
Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Instruction sets preliminaries - ARM Processor – CPU: programming input and output supervisor mode, exceptions and traps – Co-processors- Memory system mechanisms – CPU performance- CPU power consumption.	
UNIT II EMBEDDED COMPUTING PLATFORM DESIGN	**(9 Periods)**
CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture – platform-level performance analysis - Components for embedded programs Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.	
UNIT III SENSOR INTERFACING WITH ARDUINO	**(9 Periods)**
Basics of hardware design and functions of basic passive components-sensors and actuators-Arduino code - library file for sensor interfacing-construction of basic applications.	
UNIT IV EMBEDDED FIRMWARE	**(9 Periods)**
Reset Circuit, Brown-out Protection Circuit-Oscillator Unit - Real Time Clock-Watchdog Timer - Embedded Firmware Design Approaches and Development Languages.	
UNIT V EMBEDDED C PROGRAMMING	**(9 Periods)**
Introduction-Creating hardware delays‘ using Timer 0 and Timer 1-Reading switches-Adding Structure to the code-Generating a minimum and maximum delay-Example: Creating a portable hardware delay- Timeout mechanisms-Creating loop timeouts-Testing loop timeouts- hardware timeouts-Testing a hardware timeout	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical:0 Periods** **Total:45Periods**

TEXT BOOKS:

*1.Marilyn Wolf, — "**Computers as Components - Principles of Embedded Computing System Design"**, Third Edition —Morgan Kaufmann Publisher (An imprint from Elsevier), 2012. (unit I & II)*
2 https://www.coursera.org/learn/interface-with-arduino#syllabus (Unit III)
*3 .Michael J. Pont, — "**Embedded C"**, 2nd Edition, Pearson Education, 2008.(Unit IV & V)*

REFERENCE BOOKS:

*1.Shibu K.V, "**Introduction to Embedded Systems"**, McGraw Hill.2014.*
*2.Jonathan W.Valvano, "**Embedded Microcomputer Systems Real Time Interfacing"**, Third Edition Cengage Learning, 2012.*
*3 Raj Kamal, "**Embedded Systems-Architecture, Programming and Design"**, 3 edition, TMH.2015.*
*4. Lyla, "**Embedded Systems"**, Pearson, 2013.*
*5. David E. Simon, "**An Embedded Software Primer"**, Pearson Education, 2000.*

COURSE OUTCOMES:

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

CO1: Describe the architecture and programming of ARM processor.
CO2: Explain the concepts of embedded systems.
CO3: Understand the Concepts of peripherals and interfacing of sensors.
CO4: Capable of using the system design techniques to develop firmware
CO5: Illustrate the code for constructing a system .

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO5	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPE $09	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPE$10	DATA COMMUNICATION NETWORKS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the division of network functionality into layers.
- To familiarize the functions and protocols of each layer of TCP/IP protocol suite.
- To understand the fLow of information from one node to another node in the network.
- To understand the components required to build different types of network.
- To learn concepts related to network addressing.

UNIT I DATA COMMUNICATIONS	**(9 Periods)**
Transmission Impairments – Bandwidth Limitations –Multiplexing and Spreading– Encoding Techniques – Transmission Media – guided Media –Unguided Media:Wireless- Cable Pinouts – Crossover – Straight Through – Rollover-Switching-Circuit Switching-Datagram Switching-Virtual Circuit Switching- ISO/OSI Model.	
UNIT II DATA LINK LAYER	**(9 Periods)**
Link Layer – Framing – Addressing – Error Detection/Correction – Multiple Access Protocols – Address Resolution Protocol (ARP) – Ethernet Basics – CSMA/CD – Token Ring- FDDI- Virtual LAN (VLAN) – Wireless LAN (802.11) – Bluetooth – Bluetooth Low Energy – WiFi – 6LowPAN–Zigbee WAN Technologies – ATM – Frame Relay – MPLS.	
UNIT III NETWORK LAYER	**(9 Periods)**
IPV4 Address -Packet Format – IP Addressing – Subnetting – IPV6 Address-Packet Format-Transition from IPV4 to IPV6- Classless Inter Domain Routing (CIDR) – Private Addressing – Network Address Translation – BOOTP/DHCP-ICMP – Routing Principles – Distance Vector Routing(RIP) – Link State Routing (OSPF) – Path Vector Routing (BGP).	
UNIT VI TRANSPORT LAYER	**(9 Periods)**
Process to Process Delivery – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Stream Control Transmission Protocol (SCTP) – Congestion Control in TCP – Congestion Control in Frame Relay- Integrated Services-RSVP-Differentiated Services.	
UNIT V INTRODUCTION / APPLICATION LAYER	**(9 Periods)**
Evolution of Computer Networking – Network edge and core-Layered Architecture – Internet Architecture (TCP/IP) – Addressing-physical Addressing-Logical addressing-Port Addressing-Application Layer Protocols – DNS- HTTP – FTP – Telnet – Email – RTP-RTCP-Voice over IP.	

Contact Periods:
Lecture:45 Periods Tutorial:0 Periods Practical:0 Periods Total:45 Periods

TEXT BOOKS:

1. *1.Behrouz A Forouzan , **"Data Communications and Networking"** ,Tata McGraw-Hill, fourth Edition,2017.*
2. *William Stallings, — "**Data and Computer Communications"**, Tenth Edition, Pearson Education, 2013.*

REFERENCE BOOKS:

1. *James F. Kurose, Keith W. Ross, — "**Computer Networking, A Top-Down Approach Featuring the Internet"**, Sixth Edition, Pearson Education, 2012.*
2. *Larry L. Peterson, Bruce S. Davie, — "**Computer Networks: A Systems Approach"**, Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
3. *Douglas E. Comer, — "**Internetworking with TCP/IP (Volume I) Principles, Protocols and Architecture"**, Sixth Edition, Pearson Education, 2013.*
4. *Nader F. Mir, — "**Computer and Communication Networks"**, Second Edition, Prentice Hall, 2014.*
5. *Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, — "**Computer Networks: An Open Source Approach"**, McGraw Hill Publisher, 2011.*
6. *Rich Seifert, James Edwards, — "**The All New Switch Book: The Complete Guide to LAN Switching Technology"**, Wiley Publishing Inc, 2008*

COURSE OUTCOMES:

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

CO1: Identify the components required to build different types of networks
CO2: Choose the required functionality at each layer for given application
CO3: Identify solution for each functionality at each layer
CO4: Trace the flow of information from one node to another node in the network

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPE $10	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPE$11	FIBER OPTIC COMMUNICATIONS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge about the optical communication systems and optical fibers.
- To study about optical transmitter, receiver and basic elements used in the construction of optical systems.
- To gain knowledge about advanced technologies in optical systems and system configuration.

UNIT- I : INTRODUCTION	**(9 Periods)**
Optical Spectral bands, Evolution of fiber optical system -Elements of Optical Fiber Systems – Optical Fiber Modes and Configurations- Mode theory of Circular Wave guides – Single Mode Fiber – Graded Index fiber - Fiber Materials-Signal degradation in fibers-Advantages and applications of fiber optic transmission systems.	
UNIT- II : OPTICAL TRANSMITTER	**(9 Periods)**
Optical sources- Light-Emitting Diodes (LEDs)- Laser Diodes -Light Source Linearity – Reliability Considerations-Comparison and applications–Transmitter Design.	
UNIT- III : OPTICAL RECEIVER	**(9 Periods)**
Photo detectors-Photodiodes, Avalanche photo diodes- Comparisons of photo detector- Receiver Noise and sensitivity-Digital Receiver Performance-BER Calculation-Eye Diagrams.	
UNIT- IV : SYSTEM CONFIGURATIONS	**(9 Periods)**
Optical link design - Optical Power Launching and Coupling -System Design considerations – Optical amplifiers - EDFA, Raman amplifier- Multiplexing strategies –Wavelength division multiplexing.	
UNIT- V : ADVANCES IN OPTICAL FIBER SYSTEMS	**(9 Periods)**
DWDM -SONET/SDH –Wavelength Routing Networks - Optical switches -Optical fiber LAN link – Ultra High Capacity Networks - Optical networking technology in enterprise.	

Contact periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Keiser G, "**Optical Fiber Communications**", McGraw Hill, New Delhi, Fifth edition, 2014.*
2. *John M. Senior, "**Optical Fiber Communications Principles and Practice**", PHI, New Delhi, Third edition, 2009.*

REFERENCE BOOKS:

1. *G.P. Agrawal, "**Fiber optic Communication Systems**", John Wiley and sons, Fourth Edition, 2011*
2. *Franz J.H. Jain V.K, "**Optical Communication, Components and systems**", Narosa publications, New Delhi, 2000.*
3. *Gower, J "**Optical Communication Systems**", PHI, New Delhi, Second edition, Fifth reprint, 2001*
4. *K. Mynbaev and Lowell L Scheiner, "**Fiber Optic Communication Technology**", Prentice Hall 2001.*

COURSE OUTCOMES:

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

CO1: To recognize the structures, types of optical fibers and applications of optical communication systems.

CO2: To understand the principles of optical sources, detectors and analyze the functioning of optical receivers.

CO3: To understand the losses in the fiber and to understand and analyze the functioning of optical components.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	M	-	-	-	M	-	-	-	-	-	H	-	-
CO2	-	-	M	H	M	-	-	-	-	-	-	-	H	-	-
CO3	-	-	-	-	H	-	-	M	-	-	-	-	H	-	-
18LPE $11	H	M	M	H	H	-	M	M	-	-	-	-	H	-	-

L - Low, M - Moderate (Medium), H - High

18LPE$12	ADVANCED DIGITAL SIGNAL PROCESSING

Category: PE

PRE-REQUISITES: 18LPC504 – Digital Signal Processing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To have in-depth knowledge on random signal and its spectrum estimation.
- To design adaptive filters.
- To have in-depth knowledge on multirate DSP systems.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING	**(9 Periods)**
Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem, special types of random process – Signal modeling-Least Squares method, Pade approximation, Prony's method, iterative Prefiltering, Finite Data records, Stochastic Models.	
UNIT II SPECTRUM ESTIMATION	**(9 Periods)**
Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method.	
UNIT III LINEAR ESTIMATION AND PREDICTION	**(9 Periods)**
Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion - Wiener filter - Discrete Wiener Hoff equations - Recursive estimators - Kalman filter - Linear prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.	
UNIT IV ADAPTIVE FILTERS	**(9 Periods)**
FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS - Sliding window RLS - Simplified IIR LMS Adaptive filter.	
UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING	**(9 Periods)**
Mathematical description of change of sampling rate - Interpolation and Decimation - Continuous time model - Direct digital domain approach - Decimation by integer factor - Interpolation by an integer factor - Single and multistage realization - Poly phase realization - Applications to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.	

Contact periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Monson H. Hayes, "**Statistical Digital Signal Processing and Modeling**", John Wiley and Sons Inc., New York, 2006.*
2. *Simon Haykin, "**Adaptive Filter Theory**", Prentice Hall, Englehood Cliffs, NJ1986.*

REFERENCE BOOKS:

1. *Sophoncles J. Orfanidis, "**Optimum Signal Processing** ", McGraw-Hill, 2000.*
2. *John G. Proakis, Dimitris G. Manolakis, "**Digital Signal Processing**", Prentice Hall of India, New Delhi, 2005.*
3. *S. Kay," **Modern Spectrum Estimation Theory And Application**", Prentice Hall, Englehood Cliffs, Nj1988.*
4. *P. P. Vaidyanathan, "**Multirate Systems And Filter Banks**", Prentice Hall, 1992.*

COURSE OUTCOMES:

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

CO1: Have in-depth knowledge on random signal and its spectrum estimation.

CO2: Design adaptive filters.

CO3: Design multirate DSP systems

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L
CO2	H	H	L	-	-	-	-	-	-	-	-	-	H	M	L
CO3	H	L	L	-	-	-	-	-	-	-	-	-	H	M	L
18LPE $12	H	M	L	-	-	-	-	-	-	-	-	-	H	M	L

L - Low, M - Moderate (Medium), H - High

18LPE$13	LOW POWER VLSI

Category: PE

PRE-REQUISITES: 18LPC602 VLSI DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To expose the students to Low voltage and Low power VLSI CMOS circuit design.

UNIT I: BASICS OF MOS CIRCUITS	**(9 Periods)**
MOS Transistor structure and device modeling - MOS Inverters - MOS Combinational Circuits - Different Logic Families.	
UNIT II: POWER DISSIPATION & SCALING APPROACHES	**(9 Periods)**
Dynamic Power Dissipation: Short Circuit Power - Switching Power - Gliching Power, Static Power Dissipation, Degrees of Freedom. Supply Voltage Scaling Approaches: Device feature size scaling - Multi-Vdd Circuits - Architectural level approaches: Parallelism, Pipelining -Voltage scaling using high-level transformations- Dynamic voltage scaling- Power Management.	
UNIT III: SWITCHED CAPACITANCE MINIMIZATION APPROACHES	**(9 Periods)**
Hardware Software Tradeoff –Memory bus encoding - Two's complement Vs Sign Magnitude - Architectural optimization - Clock Gating.	
UNIT IV: LEAKAGE POWER MINIMIZATION & SPECIAL CIRCUITS	**(9 Periods)**
Logic styles leakage power minimization approaches: Variable-threshold-voltage CMOS (VTCMOS) approach - Multi-threshold-voltage CMOS (MTCMOS) approach - Power gating - Transistor stacking - Dual-Vt assignment approach (DTCMOS). Special circuits: Adiabatic Switching Circuits - Battery-aware Synthesis - Variation tolerant design.	
UNIT V: SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER	**(9 Periods)**
Synthesis for Low power, Behavioural level transforms, Software design for Low power.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. Sung Mo Kang, Yusuf Leblebici, "**CMOS Digital Integrated Circuits"**, Tata Mcgraw Hill, 2003.*

*2. Neil H. E. Weste and K. Eshraghian, "**Principles of CMOS VLSI Design"**, 2nd Edition, Addison Wesley (Indian reprint), 2011.*

*3. Anantha P. Chandrakasan and Robert W. Brodersen, "**Low Power Digital CMOS Design"**, Kluwer Academic Publishers, 1995.*

REFERENCE BOOKS:

*1. Kaushik Roy and Sharat C. Prasad, "**Low-Power CMOS VLSI Design"**, Wiley-Interscience, 2000.*

*2. A. Bellamour, and M. I. Elmasri, "**Low Power VLSI CMOS Circuit Design"**, Kluwer Academic Press, 1995.*

COURSE OUTCOMES:

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

CO1: An exposure on MOS Circuits and Supply Voltage Scaling Approaches.

CO2: Acquire knowledge on switched capacitance minimization approaches and leakage power minimization.

CO3: Analyze the synthesis and software design for Low power.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	L	L	M	-	H	H	-	-	L	-	H	H	L	H
CO2	L	L	L	M	-	H	H	-	-	L	-	H	H	L	H
CO3	M	L	L	M	-	H	H	-	-	L	-	H	H	L	H
18LPE $13	L	L	L	M	-	H	H	-	-	L	-	H	H	L	H

L - Low, M - Moderate (Medium), H - High

18LPE$14	WIRELESS TECHNOLOGIES

PRE-REQUISITES: 18LPC502 DIGITAL COMMUNICATION **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To know the characteristic of wireless channel, understand the cellular architecture and the concepts behind various digital signalling schemes for fading channels, familiar with the various multipath mitigation techniques, multiple antenna systems, wireless networks and their recent trends.

UNIT- I : WIRELESS CHANNELS	**(9 Periods)**
Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters- Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading –	
UNIT- II : MULTIPATH MITIGATION TECHNIQUES AND MULTIPLE ANTENNA TECHNIQUES	**(9 Periods)**
MULTIPATH MITIGATION TECHNIQUES: Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macrodiversity, Diversity combining techniques, Error probability in fading channels with diversity reception, RAKE receiver. **MULTIPLE ANTENNA TECHNIQUES:** MIMO systems – spatial multiplexing -System model - Pre-coding - Beam forming - transmitter diversity, receiver diversity.	
UNIT- III : CELLULAR ARCHITECTURE	**(9 Periods)**
Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse - channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.	
UNIT- IV : NOMA MIMO AND IoT	**(9 Periods)**
NOMA in Single-Input-Single-Output Systems-Impact of User Pairing on NOMA - Cognitive Radio Inspired NOMA –NOMA in Multi Input –Multi-Output Systems- System Model for MIMO NOMA schemes-Flexible Physical Layer Design-Generalized Frequency Division Multiplexing-Software Defined Waveform-GFDM Receiver Design. Introduction to the Internet of Things (IoT) - IoT Traffic Patterns in Network Access - The Features of Cellular Access That Are Suitable for the IoT - Overview of Cellular Access Protocols - Emerging Technologies for the IoT.	
UNIT- V : MILLIMETRE WAVE COMMUNICATION AND LiFi	**(9 Periods)**
Millimetre Wave Radio Propagation- Radio Attenuation-Free Space Path Loss-Severe Shadowing-Millimetre Wave Channel Model- Link Budget Analysis-Beamforming Architectures – Analog Beam forming Solutions – Hybrid Beamforming Solutions. LiFi LED Technologies, LiFi Attocell Networks, Differences between Light-Fidelity and Visible Light Communication, Practical Cell Deployment Scenarios, LiFi Attocell Networks Versus Other Small-Cell Networks	

Contact periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Jochen Schiller, "**Mobile Communications**", Second Edition, Pearson Education 2012.(Unit I,II,III).*
2. *Rappaport,T.S., "**Wireless communications**", Second Edition, Pearson Education, 2010. (Unit I,II,III).*
3. *Vincent W. S. Wong, Robert Schober, Derrick Wing Kwan Ng, Li-Chun Wang, "**Key Technologies for 5G Wireless Systems"**, Cambridge University Press, 2017.*
4. *Andreas.F. Molisch, "**Wireless Communications**", John Wiley – India, 2006.*

REFERENCE BOOKS:

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 Edition, Elsevier 2011.*
3. *Simon Haykin , Michael Moher, David Koilpillai, "**Modern Wireless Communications**", First Edition, Pearson Education 2013.*
4. *David Tse and Pramod Viswanath, "**Fundamentals of Wireless Communication**", Cambridge University Press, 2005.*
5. *Upena Dalal, "**Wireless Communication**", Oxford University Press, 2009.*

COURSE OUTCOMES:

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

CO1: Characterize wireless channels and understand the concept of cellular system

CO2: Compare multipath mitigation techniques and analyze their performance

CO3: Design and implement systems with transmit/receive diversity and MIMO systems and analyze their performance

CO4: Conversant with the latest trends in 5G technologies such as Millimetre Wave communication, LiFi and IoT.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LPE $14	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LPE$15	DIGITAL IMAGE AND VIDEO PROCESSING

PRE-REQUISITES: 18LPC504-DIGITAL SIGNAL PROCESSING **Category: PE**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

* This course enables the students to understand image and video processing fundamentals and algorithms for real time applications.

UNIT- I : DIGITAL IMAGE FUNDAMENTALS	**(9 Periods)**
Digital image fundamentals - Elements of Visual perception, Image Sensing and Acquisition - Image Sampling and Quantization - Pixels Relationships - Basics of Color image processing - Color Models – RGB, YUV, HSI – Color transformations – formulation, color components, color slicing, tone and color corrections.	
UNIT- II : IMAGE ENHANCEMENT	**(9 Periods)**
2D transforms-Discrete Fourier Transform and its inverse - Properties and applications. Gray level transformations - Histogram Equalization and Specification techniques – Pixel domain smoothing filters – linear and order-statistics - Pixel domain sharpening filters – first and second order derivatives – Frequency Domain filtering – Low pass and High pass – Homomorphic filtering.	
UNIT- III : IMAGE COMPRESSION	**(9 Periods)**
Image compression – Redundancy – interpixel and psycho visual – Lossless Compression – predictive and entropy – Lossy Compression – Predictive and transform coding – Discrete Cosine Transform – Compression standards – JPEG and JPEG 2000. Discrete Wavelet transform and its properties.	
UNIT- IV : VIDEO FUNDAMENTALS	**(9 Periods)**
Fundamentals of video coding – Inter-frame redundancy – Motion Estimation techniques – Full Search and Fast Search Strategies – Forward and Backward motion prediction – Frame Classification – I, P and B. Video Sequence Hierarchy – Group of pictures, frames, slices, macro blocks and blocks. Elements of video encoder and decoder – Video coding standards – MPEG and H.26X.	
UNIT- V : IMAGE AND VIDEO SEGMENTATION	**(9 Periods)**
Detection of Discontinuities - Edge linking and boundary detection – Thresholding – global and adaptive – Region based segmentation. Video Segmentation – Temporal segmentation – Shot boundary detection – Hard-cuts and Soft-cuts - spatial segmentation – Motion based – Video object detection and tracking.	

Contact periods:
Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. Rafael C. Gonzales, Richard E. Woods, **"Digital Image Processing"**, Third Edition, Pearson Education, 2010.*

*2. Murat Tekalp, **"Digital Video Processing"**, Prentice Hall, 2nd Edition, 2015.*

REFERENCE BOOKS:

1. *Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, **"Digital Image Processing Using MATLAB"**, Third Edition Tata McGraw Hill Pvt. Ltd., 2011.*
2. *Anil Jain K. **"Fundamentals of Digital Image Processing"**, PHI Learning Pvt. Ltd., 2011.*
3. *Willliam K Pratt, **"Digital Image Processing"**, John Willey, 2002.*
4. *Malay K. Pakhira, **"Digital Image Processing and Pattern Recognition"**, First Edition, PHI Learning Pvt. Ltd., 2011.*

COURSE OUTCOMES:

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

CO1: Understanding of Digital Image fundamentals
CO2: Ability to develop efficient Image enhancement algorithms
CO3: Knowledge on basic image coding schemes and image compression standards
CO4: Understanding of video fundamentals and video standards
CO5: Knowledge on Image and Video segmentation and representation schemes

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	L	-	H	L	-	-	-	-	-	-	-	L	-	-
CO2	L	M	-	H	L	M	-	-	-	-	-	-	M	-	-
CO3	M	M	-	M	L	-	-	-	-	-	-	-	M	-	-
CO4	M	L	-	H	L	-	-	-	-	-	-	-	L	-	-
CO5	L	M	-	M	L	-	-	-	-	-	-	-	M	-	-
18LPE $15	M	M	-	H	L	M	-	-	-	-	-	-	M	-	-

L - Low, M - Moderate (Medium), H - High

18LPE$16	CONTROL SYSTEMS

PRE-REQUISITES: 18LPC305 SIGNALS AND SYSTEMS **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- This course enables the students to compute transfer function of the system, analyze time and frequency response, stability and state variables of the system.

UNIT- I : MODELING OF CONTROL SYSTEMS	**(9 Periods)**
Basic Elements of Control System - Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph.	
UNIT- II : TIME RESPONSE ANALYSIS	**(9 Periods)**
Time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems - Steady state errors - P, PI, PD and PID Compensation.	
UNIT- III : FREQUENCY RESPONSE ANALYSIS	**(9 Periods)**
Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots - Constant M and N Circles - Nichol's Chart - Use of Nichol's Chart in Control System Analysis-Series, Parallel, series-parallel Compensators - Lead, Lag, and Lead Lag Compensators.	
UNIT- IV : STABILITY ANALYSIS	**(9 Periods)**
Stability - Routh-Hurwitz Criterion, Root Locus Technique- Construction of Root Locus - Dominant Poles, Application of Root Locus Diagram - Nyquist Stability Criterion - Relative Stability.	
UNIT- V : STATE VARIABLE ANALYSIS	**(9 Periods)**
State space representation of Continuous Time systems - State equations - Transfer function from State Variable Representation - Solutions of the state equations – Kalman's test of Controllability and Observability - State space representation for Discrete time systems- Sampled Data control systems- Sampling Theorem- Sampler and Hold - Open loop and Closed loop sampled data systems.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**

TEXT BOOKS:

1. *J.Nagrath and M.Gopal, "**Control Systems Engineering**", NewAge International Publishers, 5th Edition, 2008.*
2. *Norman Nise, **" Control Systems Engineering"** John Wiley & Sons, 6th Edition,2011*

REFERENCE BOOKS:

1. B. *C. Kuo, **"Digital Control Systems"**, Oxford University Press, 2/e, Indian Edition, 2007.*
2. *M.Gopal, "**Control System – Principles and Design**", Tata McGraw Hill, 4th Edition, 2012.*
3. *Ogata K, **"Modern Control Engineering"**, PHI Publishers, 5th Edition, 2010.*
4. *Richard C. Dorf & Robert H. Bishop, "**Modern Control Systems**", Prentice Hall, 12th edition, 2010.*
5. *Constantine H. Houpis, Stuart N. Sheldon, "**Linear Control System Analysis and Design with MATLAB**", CRC Press, 6th edition 2013.*

COURSE OUTCOMES:

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

CO1: An ability to compute differential equation and transfer function of a given control system

CO2: Knowledge on time response analysis.

CO3: Ability to analyze the frequency domain response.

CO4: Ability to analyze the stability of the system.

CO5: Knowledge on state variable analysis.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	H	M	L	-	-	-	-	-	-	-	L	M	-	-
CO2	M	L	L	-	-	-	-	-	-	-	-	L	M	-	-
CO3	M	H	H	L	-	-	-	-	-	-	-	M	M	M	-
CO4	M	H	H	M	-	-	-	-	-	-	-	M	M	M	-
CO5	L	M	-	-	-	-	-	-	-	-	-	M	M	-	-
18LPE$16	M	H	H	M	-	-	-	-	-	-	-	M	M	M	-

L - Low, M - Moderate (Medium), H - High

18LPE$17	ADHOC AND WIRELESS SENSOR NETWORKS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Learn Ad hoc network and Sensor Network fundamentals
- Understand the different routing protocols
- Have an in-depth knowledge on sensor network architecture and design issues
- Understand the transport layer and security issues possible in Ad hoc and Sensor networks
- Have an exposure to mote programming platforms and tools

UNIT I ADHOC NETWORKS – INTRODUCTION AND ROUTING	**(9 Periods)**
Elements of Adhoc Wireless Networks, Issues in Ad hoc wireless networks, Example commercial applications of Adhoc networking, Ad hoc wireless Internet, Issues in Designing a Routing Protocol for AdHoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols - Destination Sequenced Distance Vector (DSDV), On–Demand Routing protocols –Ad hoc On–Demand Distance Vector Routing (AODV).	
UNIT II SENSOR NETWORKS – INTRODUCTION & ARCHITECTURES	**(9 Periods)**
Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, WSN application examples, Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture - Sensor Network Scenarios, Transceiver Design Considerations, Optimization Goals and Figures of Merit.	
UNIT III WSN NETWORKING CONCEPTS AND PROTOCOLS	**(9 Periods)**
MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Contention based protocols - PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Routing Protocols Energy Efficient Routing, Challenges and Issues in Transport layer protocol.	
UNIT IV SENSOR NETWORK SECURITY	**(9 Periods)**
Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks.	
UNIT V SENSOR NETWORK PLATFORMS AND TOOLS	**(9 Periods)**
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.	

Contact Periods:

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total:45 Periods

TEXT BOOKS:

1. *C. Siva Ram Murthy and B. S. Manoj, — "**Ad Hoc Wireless Networks Architectures and Protocols"**, Prentice Hall, PTR, 2004. (UNIT I)*
2. *Holger Karl , Andreas willig, — "**Protocol and Architecture for Wireless Sensor Networks"**, John wiley publication, Jan 2006.(UNIT II-V)*

REFERENCE BOOKS:

1. *Feng Zhao, Leonidas Guibas, — "**Wireless Sensor Networks: an information processing approach"**, Elsevier publication, 2004.*
2. *Charles E. Perkins, — "**Ad Hoc Networking"**, Addison Wesley, 2000.*
3. *I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, — "**Wireless sensor networks: a Survey"**, computer networks, Elsevier, 2002, 394 - 422.*

COURSE OUTCOMES:

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

CO1: Know the basics of Ad hoc networks and Wireless Sensor Networks.
CO2: Apply this knowledge to identify the suitable routing algorithm based on the network and user requirement.
CO3: Apply the knowledge to identify appropriate physical and MAC layer protocols.
CO4: Understand the transport layer and security issues possible in Ad hoc and sensor networks.
CO5: Be familiar with the OS used in Wireless Sensor Networks and build basic modules.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	L	-	L	-	-	L	M	L	-
CO2	-	-	-	L	L	-	-	-	-	-	-	-	L	L	-
CO3	M	-	-	-	-	-	L	-	L	-	-	-	L	-	-
CO4	M	L	M	M	M	L	L	-	-	L	L	L	M	M	-
CO5	M	-	-	-	M	L	L	-	-	L	L	-	M	L	-
18LPE $17	M	L	L	M	M	L	L	-	L	L	L	L	M	L	-

L - Low, M - Moderate (Medium), H - High

18LPE$18	SATELLITE COMMUNICATION

PRE-REQUISITES: 18LPC502 DIGITAL COMMUNICATION **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To Learn Current state and advantages of Satellite Communication.
- To understand satellite orbits and trajectories.
- To Have Knowledge on different satellite subsystems and multiple access methods.
- To understand different aspects of communication link design.

UNIT I: SATELLITE ORBITS	**(9 Periods)**
Orbital Mechanics - Orbit Equations- Kepler's Laws - Orbital Period -Orbits and their types - Orbital Spacing- look angle calculation -Satellite Launch - Propagation Delay-System Performance.	
UNIT II: SATELLITE SUBSYSTEM	**(9 Periods)**
AOCS -TTC&M –Power – Transponders - Antennas -earth control-Effects of earth Perturbation-suntransit-moontransit-satellite power design -MTBF -Basic Equations -System Noise and G/T ratio –Uplink- Downlink and Design for a specified C/N ratio - GEO and LEO examples -Atmospheric and Rain effects on link performance.	
UNIT III: SATELLITE LINK DESIGN	**(9 Periods)**
Link design equation -noise temperature - atmospheric effects on link design -interference effects - earth station parameters -earth space propagation effects - frequency window - free space loss - Ionospheric scintillation- telemetry -tracking and command of satellites - Digital Modulation for satellite systems - Error control requirements for satellite.	
UNIT IV: SATELLITE MULTIPLE ACCESS SYSTEM	**(9 Periods)**
FDMA techniques -SCPC and CSSB systems - TDMA frame structure- burst structure- frame efficiency -super-frame - frame acquisition and synchronization -TDMA vs FDMA - burst time plan- beam hopping - satellite switched -Erlang call congestion formula - DA-FDMA -DA-TDMA	
UNIT V: SATELLITE SERVICES	**(9 Periods)**
Remote sensing- navigation - scientific and military application -VSAT -Network architecture – AccessControl protocols and techniques - VSAT Earth stations- Satellite Mobile Telephony - Global star - DBS/DTH Television – GPS - Weather satellites.	

Contact periods:

Lecture:45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

1. *T.Pratt, C. Bostian and J.Allnutt; — "**Satellite Communications"**, John Wiley and Sons, Second Edition, 2003.*
2. *D.Rody, — "**Satellite Communications"**, McGraw-Hill Professional, Fourth Edition, 2006.*

REFERENCE BOOKS:

*1. W.L.Pritchard,H G Suyderhoud and R A Nelson, — "**Satellite Communication System Engineering"**, Second edition, Prentice Hall, 1993.*

*2.Tri. T. Ha, — "**Digital Satellite Communications"**, McGraw Hill, Second Edition, 1990.*

*3. B.N.Agarwal, — "**Design of Geosynchronous Space craft"**, Prentice Hall, 1986.*

*4.M. Richharia, — "**Satellite communication systems"**, McGraw-Hill Professional , 1999.*

COURSE OUTCOMES:

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

CO 1: Knowledge on basics of Satellite Communication.

CO 2: Ability to understand satellite orbits and trajectories.

CO 3: Have Knowledge on different satellite subsystems.

CO 4: Ability to understand different aspects of communication link design.

CO 5: Knowledge on multiple access methods.

CO 6: Knowledge on important applications of satellites

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	L	-	L	-	-	L	M	L	-
CO2	-	-	-	L	L	-	-	-	-	-	-	-	L	L	-
CO3	M	-	-	-	-	-	L	-	L	-	-	-	L	-	-
CO4	M	L	M	M	M	L	L	-	-	L	L	L	M	M	-
CO5	M	-	-	-	M	L	L	-	-	L	L	-	M	L	-
CO6	L	-	-	-	L	L	L	-	-	-	L	-	L	L	-
18LPE $18	M	L	L	M	M	L	L	-	L	L	L	L	M	L	-

L - Low, M - Moderate (Medium), H - High

18LPE$19	HIGH SPEED ELECTRONICS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- The course aims to give exposure on the band diagram, characteristics of hetero-junction devices and fabrication techniques.

UNIT- I : SEMICONDUCTOR MATERIALS CHARACTERISTICS	**(9 Periods)**
Review of Crystal Structure: Crystal structure of important semiconductors (Si, GaAs, InP) - electrons in periodic lattices - energy band diagram - carrier concentration and carrier transport phenomenon - electrical - optical - thermal and high field properties of semiconductors.	
UNIT- II : HOMOJUNCTION DEVICES	**(9 Periods)**
Homojunction Devices (BJT and FET): Structure - band diagram - operation - I–V and C–V characteristics (analytical expressions) - small signal switching models.	
UNIT- III : MOS DEVICES	**(9 Periods)**
MOS Diode: Structure - band diagram - operation - C–V characteristics - effects of oxide charges - avalanche injection - high field effects and breakdown; Heterojunction Based MOSFET: Band diagram - structure - operation - I– V and C–V characteristics (analytical expressions) - MOSFET breakdown and punch through - subthreshold current - scaling down; Alternate High k-dielectric Materials: HF–MOSFETs - SOI MOSFET - buried channel MOSFET - charge coupled devices.	
UNIT- IV : ADVANCED DEVICES	**(9 Periods)**
HBT and HEMT Devices: AlGaAs/ GaAs, InP and SiGe based HBT and HEMT structure - band diagram - operation - I–V and C–V characterist ics (analytical expressions) - small signal switching models - benefits of heterojunction transistor for high speed applications.	
UNIT- V : FABRICATION AND CHARACTERIZATION TECHNIQUES	**(9 Periods)**
Crystal Growth and Wafer Preparation: Epitaxy - diffusion - ion implantation - dielectric film deposition and oxidization techniques - masking and lithography techniques (optical, e-beam and other advanced lithography techniques) - metallization - bipolar and MOS integration techniques - interface passivation techniques; Characterization Techniques: Four probe and hall effect measurement - I–V and C–V for dopant profile characterization and DLTS.	

Contact Periods:

Lecture: 45 Periods Tutorial: 0Periods Practical: 0Periods Total: 45 Periods

TEXT BOOKS:

*1. Nandita Das Gupta and Amitava Das Gupta, "**Semiconductor Devices: Modeling and Technology"**, Prentice Hall of India, 2004.*

*2. Doering R and Nishi Y, "**Handbook of Semiconductor Manufacturing Technology"**, 2nd ed. Boca Raton, FL: CRC Press, Taylor & Francis Group, 2008*

REFERENCE BOOKS:

*1. Wolf S and Tauber RN, "**Silicon processing for the VLSI era Volume 1 – Process Technology"**, 2nd ed. Sunset Beach, CA: Lattice Press, 2000.*
*2. M. S. Tyagi, "**Introduction to Semiconductor Materials and Devices"**, John Wiley and Sons, 2008.*
*3. S. M. Sze, "**Physics of Semiconductor Devices"**, 3 rd edition, John Wiley and Sons, 2007*
*4. J. Singh, "**Semiconductor Devices: Basic Principles"**, John Wiley and Sons, 2007.*

COURSE OUTCOMES:

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

CO1: Understand the characteristics of semiconductor materials and the structure of metal semiconductor devices.
CO2: Analyse the characteristics of Homojunction devices.
CO3: Understand the technology of MOS
CO4: Advanced devices and their fabrication techniques.
CO5: Understand the MOS integration techniques.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	H	-	-	-	-	L	L	L	M	L	M
CO2	H	M	M	L	L	-	-	-	-	L	L	M	M	H	M
CO3	H	H	H	M	L	-	-	-	-	L	M	L	L	-	-
CO4	H	L	M	M	L	-	-	-	-	L	L	M	M	L	L
CO5	H	M	M	M	L	-	-	-	H	L	L	H	L	L	L
18LPE $19	H	M	M	M	L	-	-	-	H	L	L	M	M	M	M

L - Low, M - Moderate (Medium), H - High

18LPE$20	WAVELET TRANSFORM

PRE-REQUISITES:18LPC305- SIGNALS AND SYSTEMS **Category: PE**
18LPC504-DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This course enables the students to understand the significance of wavelets, continuous and discrete wavelet transforms and applications of wavelets.

UNIT- I : INTRODUCTION	**(9 Periods)**
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 Periods)**
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	**(9 Periods)**
Discrete Wavelet Transform And Filter banks - Orthogonal and biorthogonal 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 Periods)**
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 Periods)**
Signal and Image compression - Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers, Image fusion, Edge Detection and object isolation.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Stephan Mallet, "**A Wavelet Tour of Signal Processing: The Sparse Way**" 3rd Edition, Academic Press, 2009.*
2. *Martin Vetterli and Jelena Kovacevic, "**Wavelets and Subband Coding",** Prentice Hall PTR, 1995.*

REFERENCE BOOKS:

1. *Raghuveer rao and Ajit S.Bopardikar, "**Wavelet transforms: Introduction, Theory and applications**", Pearson Education Asia, 2000.*
2. *J.C. Goswami and A.K.Chan, "**Fundamentals of Wavelets: Theory, Algorithms, and Applications**" 2nd ed., Wiley, 2011.*
3. *Gerald keiser, "**A friendly guide to Wavelets**", Springer, 2011.*

COURSE OUTCOMES:

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

CO1: Understand the basics of wavelets.
CO2: Knowledge on continuous wavelet transforms.
CO3: Knowledge on discrete wavelet transforms.
CO4: Realize the concepts of multiresolution analysis.
CO5: Illustrate the applications of wavelets in various domains.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	L	-	-	-	-	-	-	-	-	-	L	M	H	-
CO2	M	M	-	H	L	-	-	-	-	-	-	L	M	H	-
CO3	M	M	-	H	L	-	-	-	-	-	-	L	M	H	-
CO4	M	M	-	-	-	-	-	-	-	-	-	-	M	L	-
CO5	M	M	M	M	H	-	--	-	-	-	-	M	M	H	L
18LPE $20	M	M	M	H	H	-	-	-	-	-	-	M	M	H	L

L - Low, M - Moderate (Medium), H - High

18LPE$21	ERROR CORRECTING CODES

PRE-REQUISITES: 18LPC502 DIGITAL COMMUNICATION **Category:PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To explain the importance of modern coding techniques in the design of digital communication systems.

UNIT- I : LINEAR BLOCK CODES AND CONVOLUTIONAL CODES	**(9 Periods)**
Review of modern algebra. Galois fields. Linear block codes; encoding and decoding. Cyclic codes. Nonbinary codes. Convolutional codes. Generator sequences. Structural properties. ML decoding. Viterbi decoding. Sequential decoding.	
UNIT- II : LDPC CODES	**(9 Periods)**
LDPC Codes: Construction and Notation - Tanner Graph - Decoding of LDPC Codes - EXIT Chart for LDPC codes - Irregular LDPC codes - LDPC codes in 5G.	
UNIT- III : TRELLIS CODES	**(9 Periods)**
Modulation codes. Trellis coded modulation. Lattice type Trellis codes. Geometrically uniform trellis codes. Decoding of modulation codes.	
UNIT- IV : TURBO CODES	**(9 Periods)**
Turbo codes. Turbo decoder. Interleaver. Turbo decoder. MAP and log MAP decoders. Iterative turbo decoding. Optimum decoding of turbo codes.	
UNIT- V : SPACE TIME CODES	**(9 Periods)**
Space-time codes. MIMO systems. Space-time codes. MIMO systems. Space-time block codes (STBC) – decoding of STBC.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. S.Lin&D.J.Costello, "**Error Control Coding (2/e)**", Pearson, 2005.*
*2. B.Vucetic&J.Yuan, "**Turbo codes**", Kluwer, 2000.*
*3.Tood.K.Moon "**Error Correcting Codes**" A John Wiley &Sons, INC, Publication*

REFERENCE BOOKS:

1. C.B.Schlegel&L.C.Perez, "**Trellis and Turbo Coding**", Wiley,2004.
2. B.Vucetic&J.yuan, "**Space-Time Coding**", Wiley, 2003.
3. Recent literature in Error Control Coding.

COURSE OUTCOMES:

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

CO1: understand the need for error correcting codes in data communication and storage systems.

CO2: Identify the major classes of error detecting and error correcting codes and how they are used in practice. Construct codes capable of correcting a specified number of errors.

CO3: explain the operating principles of block codes, cyclic codes, convolution codes, modulation codes, Turbo codes etc..

CO4: Design an error correcting code for a given application

CO5: Understand the fundamental limits of error correction. Develop and execute encoding and decoding algorithms associated with the major classes of error detecting and error correcting codes.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M
CO2	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M
CO3	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M
CO4	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M
CO5	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M
18LPE $21	M	M	M	M	-	-	-	-	-	-	-	M	M	M	M

L - Low, M - Moderate (Medium), H - High

18LPE$22	BIO - MEDICAL ELECTRONICS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge about the various physiological parameters both electrical and non-electrical and the methods of recording and also the method of transmitting these parameters.
- To study about the various assist devices used in the hospitals.
- To gain knowledge about equipment used for physical medicine and the various recently developed diagnostic and therapeutic techniques.

UNIT- I : PHYSIOLOGY AND TRANSDUCERS	**(9 Periods)**
Cell and its structure – Resting and Action potential – Nervous system: Structure of nervous system, neurons – synapse – transmitters and neural communication – Cardiovascular system – Basic components of a biomedical system. Transducers - selection criteria – Piezo electric, ultrasonic transducers, Temperature measurements, Fibre optic temperature sensors.	
UNIT- II : ELECTRO-PHYSIOLOGICAL MEASUERMENTS	**(9 Periods)**
Electrodes – Limb and surface electrodes – Amplifiers; Preamplifiers – differential amplifiers – chopper amplifiers – Isolation amplifier. Physiological measurements – ECG, EEG, EMG, ERG – Lead systems and recording methods – Typical waveforms. Electrical safety in medical environment: shock hazards – leakage current.	
UNIT- III : NON-ELECTRICAL PARAMETER MEASUREMENTS	**(9 Periods)**
Measurement of blood pressure – cardiac output – heart rate – heart sounds – pulmonary function measurements – spirometer – blood gas analysers – pH of blood – measurement of blood pCO2, pO2, fingertip oxymeter.	
UNIT- IV : MEDICAL IMAGING AND BIOTELEMETRY	**(9 Periods)**
Computer Tomography – Magnetic Resonance Imaging – Real time Ultrasound Scanner – M mode – Different types of biotelemetry systems and patient monitoring – Wireless telemetry, single channel, multi-channel, multi patient and implantable telemetry systems	
UNIT- V : ASSISTING AND THERAPEUTIC EQUIPMENTS	**(9 Periods)**
Pacemakers – External and Internal pacemakers – Defibrillators – DC defibrillator, Implantable defibrillators – Ventillators – Surgical diathermy, safety aspects in Electro surgical units – Lithotripsy.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Khandpur R.S., "**Handbook of Bio-medical Instrumentation**" Tata McGraw Hill, New Delhi, 2004.*
2. *Leslie Cromwell, Fred J. Weibell, Erich A.Pfeiffer, "**Bio-medical Instrumentation and Measurements**", 2nd edition, Pearson Education, 2002.*

REFERENCE BOOKS:

1. *M. Arumugam, "**Bio-medical instrumentation**", Anuradha Agencies, 2003.*
2. *L.A. Geddes and L.E. Baker, "**Principles of Applied Bio-medical instrumentation**", John Wiley & Sons, 1975.*
3. *J. Webster "**Medical Instrumentation**", 3rd Edition, Wiley India Edition, 1995.*

COURSE OUTCOMES:

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

CO1: Discuss the application of electronics in diagnostic and therapeutic area.

CO2: Measure biochemical and various physiological information.

CO3: Describe the working of units which will help to restore normal functioning.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	-	H	-	-	M	-	L	-	-	-	-	H	-	-
CO2	-	-	-	H	M	-	-	-	-	-	-	-	H	-	-
CO3	-	H	-	M	-	-	-	L	-	-	-	-	H	-	-
18LPE $22	M	H	H	H	M	M	-	L	-	-	-	-	H	-	-

L - Low, M - Moderate (Medium), H - High

18LPE023	**OPERATIONS RESEARCH** (Use of Approved Statistical Tables Permitted) (Common to MECH & ECE Branches)

PRE-REQUISITES: NIL **Category: PE**

COURSE OBJECTIVES:

L	T	P	C
3	0	0	3

- To acquire knowledge of linear programming and network problems and their solving techniques.
- To develop the skill of resolving queuing situations and comprehend decision strategies.

UNIT – I: LINEAR MODELS	**(9 Periods)**
Development - Characteristics and Phases of operation research - Types of models – graphical method – simplex algorithm – duality formulation – dual simplex method. Linear Programming Problem - Formulation – Graphical solution – Simplex method - Solution by Excel solver.	
UNIT – II: NETWORK AND SEQUENCING MODELS	**(9 Periods)**
Network models – shortest route – minimal spanning tree – maximum fLow models – project network – PERT and CPM networks – critical path scheduling – sequencing models - FLow –Shop sequencing – 'n' jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines	
UNIT – III: INVENTORY, TRANSPORTATION AND ASSIGNMENT MODELS	**(9 Periods)**
Inventory models – economic order quantity models – safety stock – reorder point – lead time – quantity discount models – transportation problems – Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. Assignment problems - Formulation – Optimal solution - Variants of Assignment Problem.	
UNIT – IV: QUEUING THEORY	**(9 Periods)**
Queuing models – queuing systems and structures – notation parameter – single server and multi server models – poisson arrival – exponential service – simulation – Monte Carlo technique – use of random numbers – Exercise problems.	
UNIT –V: DECISION MODELS	**(9 Periods)**
Decision models – game theory – two person zero sum games – graphic solution – replacement models – replacement policies - models based on service life – economic life.Dynamic Programming: Introduction – Terminology - Bellman's Principle of Optimality – Applications of dynamic programming- shortest path problem.	

Contact Periods:
Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. A.M.Natarajan, P.Balasubramaniam, A. Tamilarasi "**Operations Research**", Pearson Education, 2011.*

*2. P.K. Gupta & D.S. Hira, "**Problems in Operations Research (Principles & Solutions)**", S.Chand & Co. Ltd., 2013.*

*3. Taha Hamdy A, "**Operations Research**, Prentice Hall of India Pvt. Ltd., 2010.*

REFERENCE BOOKS:

*1. Dharani Venkatakrishnan. S,"**Operations Research**" (Principles & Problems), Keerthi Publishing House Pvt. Ltd., 2006.*

*2. Don. T. Phillips, Ravindren, A and James Solberg, "**Operations Research**", John Wiley & Sons, 2009.*

*3. Fourer, D.Gay and B. Kernighan, AMPL, "**A Modeling Language for Mathematical Programme**", Brooks/Cole-Thomson, 2007.*

*4. J.K.Sharma, "**Operation Research**" MacMilan.., 2009*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

CO 1: Understand the use of linear programming problems and methods of solving

CO 2: Evaluate optimal routes with minimum distance and maximal fLow capacity so as to reduce cost.

CO 3: Apply economic ordering quantity concept to minimize inventory carrying charges.

CO 4: Analyse queuing situations thereby reduce waiting time of costumers and make effective system utilization.

CO 5: Make strategic decisions.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	H	-	-	-	-	L	L	L	M	L	M
CO2	H	M	M	L	L	-	-	-	-	L	L	M	M	H	M
CO3	H	H	H	M	L	-	-	-	-	L	M	L	L	-	-
CO4	H	L	M	M	L	-	-	-		L	L	M	M	L	L
CO5	H	M	M	M	L	-	-	-	H	L	L	H	L	L	L
18LPE $23	H	M	M	M	L	-	-	-	H	L	L	M	M	M	M

L - Low, M - Moderate (Medium), H - High

18LPE$24	SOFTWARE DEFINED RADIO

.

PRE-REQUISITES: 18LPC404 ANALOG COMMUNICATION **Category: PE**
18LPC502 DIGITAL COMMUNICATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This short course is designed to give practitioners, faculty, upperclassmen, and graduate students an overview of software-defined radio systems and the technologies necessary for their successful implementation in future communication systems.

UNIT I	INTRODUCTION TO SOFTWARE DEFINED RADIO	(9 Periods)
Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit.		
UNIT II	**SDR ARCHITECTURE**	**(9 Periods)**
Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules		
UNIT III	**INTRODUCTION TO COGNITIVE RADIOS**	**(9 Periods)**
Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.		
UNIT IV	**COGNITIVE RADIO ARCHITECTURE**	**(9 Periods)**
Cognitive Radio - functions, components and design rules, Cognition cycle - orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture		
UNIT V	**NEXT GENERATION WIRELESS NETWORK**	**(9 Periods)**
The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.		

Contact periods:
Lecture: 45Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

1. *JosephMitolaIII,"**Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering**", John Wiley & Sons Ltd. 2000.*
2. *ThomasW.Rondeau, Charles W. Bostain, "**Artificial Intelligence in Wireless communication**", ARTECH HOUSE .2009.*
3. *Bruce A. Fette, "**Cognitive Radio Technology**", Elsevier, 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.*

REFERENCE BOOKS:

1. *SimonHaykin, "**Cognitive Radio: Brain –Empowered Wireless Communications**", IEEE Journal on selected areas in communications, Feb 2005.*
2. *HasariCelebi, HuseyinArslan, "**Enabling Location and Environment Awareness in Cognitive Radios**", Elsevier Computer Communications, Jan 2008.*
3. *Markus Dillinger, KambizMadani, Nancy Alonistioti, "**Software Defined Radio**", John Wiley, 2003.*
4. *HuseyinArslan, "**Cognitive Radio, SDR and Adaptive System**", Springer, 2007.*
5. *Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, "**Cognitive Radio Communication and Networks**", Elsevier, 2010.*

COURSE OUTCOMES:

Upon completion of the course, student will be able to

CO1: Describe the basics and the architecture of SDR

CO2: Describe the basics and the architecture of Cognitive radio

CO3: Understand the wireless networks based on the cognitive radios

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	L	L	L
18LPE $24	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L

L - Low, M - Moderate (Medium), H - High

18LPE$25	INTERNET OF THINGS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn about the fundamentals of Internet of Things
- To build a small Low cost embedded system using Arduino/ Raspberry Pi or equivalent boards
- To apply the concept of Internet of Things in real world scenario.

UNIT- I : : FUNDAMENTALS OF IOT	**(9 Periods)**
Introduction-Characteristics - Physical design - Protocols-Logical design - Enabling technologies - IoT levels-Domain specific IoTs - IoTvs M2M	
UNIT- II : IOT DESIGN METHODOLOGY	**(9 Periods)**
IoT systems management - IoT design methodology-Specifications - Integration and Application Development.	
UNIT- III : IOT COMPONENTS	**(9 Periods)**
Sensors and activators - Communication modules - Zigbee-RFID-Wi-Fi-Power sources.	
UNIT- IV : BUILDING IOT WITH HARDWARE PLATFORMS	**(9 Periods)**
Platform - Arduino/Intel Galileo/Raspberry Pi- Physical device - Interfaces - Programming - APIs/Packages - Web services.	
UNIT- V : CASE STUDIES AND ADVANCED TOPICS	**(9 Periods)**
Various Real time applications of IoT-Connecting IoT to cloud-Cloud storage for IoT-Data Analytics for IoT- Software & Management Tools for IoT.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1.ArshdeepBahga, Vijay Madisetti, "**Internet of Things-A hands-on approach**", Universities Press, 2015.*

REFERENCE BOOKS:

1.Manoel Carlos Ramon, —Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers, Apress, 2014.
*2.Marco Schwartz, **—Internet of Things with the Arduino Yun**, Packt Publishing.*

COURSE OUTCOMES:

Upon completion of this course, the students will have the:

CO1: Ability to Design a portable IoT using Arduino/Equivalent boards and relevant protocols
CO2: Ability to Develop web services to access/control IoT devices
CO3: Ability to Deploy an IoT application and connect to the cloud
CO4: Ability to BuiltIoT applications for real time scenario
CO5: Ability to Analyze IoT Components
CO6: Ability to Apply IoT for various Interdisciplinary applications.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	M	H	L	L	L	L	-	-	-	-	-	H	H	M
CO2	L	M	H	L	L	L	L	-	-	-	-	-	M	M	M
CO3	L	L	H	L	-	-	-	-	-	-	-	-	M	M	M
CO4	L	L	H	L	L	L	-	-	-	-	-	-	H	H	M
CO5	L	L	M	L	L	L	-	-	-	-	-	-	M	H	L
CO6	L	L	H	L	M	M	-	-	-	-	L	-	H	H	L
18LPE $25	L	L	H	L	L	L	L	-	-	-	L	-	H	H	M

L - Low, M - Moderate (Medium), H - High

18LPE$26	MICROWAVE INTEGRATED CIRCUITS

PRE-REQUISITES: NIL **Category: PE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- The objective is to provide the basic concepts and techniques of Microwave Integrated Circuits.

UNIT I: INTRODUCTION	**(9 Periods)**
Introduction to Monolithic Microwave Integrated Circuits (MMICs) - their advantages over discrete circuits - materials - MMIC fabrication techniques - MOSFET fabrication - Thin film formation.	
UNIT II: MICROSTRIP LINES	**(9 Periods)**
Planar transmission lines for MICs – Method of conformal transformation for microchip analysis – Concept of effective dielectric constant – Effective dielectric constant for microstrip – Losses in microstrip.	
UNIT III: SLOT LINES	**(9 Periods)**
Slot Line Approximate analysis and field distribution – Transverse resonance method and evaluation of slot line impedance – Comparison with micro strip line.	
UNIT IV: LUMPED ELEMENTS FOR MICS	**(9 Periods)**
Use of Lumped elements – Capacitive elements – Inductive elements and Resistive elements.	
UNIT V: MICROWAVE SEMICONDUCTOR DEVICES & MICROWAVE PASSIVE COMPONENTS	**(9 Periods)**
Parametric amplifiers, tunnel diode, varactor diode, PIN diode, Gunn diode, their principle of operation, performance characteristics& applications, scattering parameter calculations of E plane-Tee, Magic Tee, Directional Coupler.	

Contact periods:
Lecture:45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1.Gupta KC, and Amarjit Singh, **Microwave Integrated circuits**, WileyEastern,1974.*
*2.Leo Young, **Advances in Microwaves**, Academic Press.*

REFERENCE BOOKS:

*1. Bharathi Bhat, and S.K. Koul "**stripline-like transmission lines for microwave integrated circuits**, New age international ,2007.*
*2. Samuel. Y. Liao, "**Microwave Circuit Analysis and Amplifier Design**", Prentice Hall. Inc.,1987.*
*3. T.C.Edwards, "**Foundations for Microstrip Circuit Design (2/e)**", Wiley, 1992.*
*4.Ravender Goyal, "**Monolithic MIC; Technology & Design**", Artech House, 1989.*

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Acquire knowledge about Microwave Integrated Circuits.

CO2: Gain knowledge of plannar transmission line for MIC.

CO3: Gain knowledge of slot lines for MIC.

CO4: Gain knowledge and understanding of lumped elements for MIC.

CO5: Develop understanding of the fundamentals required to design & implement Integrated Circuits operating at microwave frequencies.

CO6: Acquire knowledge about Microwave Semiconductor Devices.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	H	H	-	-	H	M	-	H	-	-	-	-	-	M	-
CO2	-	H	-	-	H	M	M	-	-	-	-	-	-	H	-
CO3	-	-	-	-	H	M	L	-	-	-	-	-	-	M	-
CO4	-	H	-	-	H	L	M	-	-	-	-	-	-	M	-
CO5	-	H	-	-	H	H	H	-	-	-	-	-	-	H	-
CO6	-	-	-	-	H	H	H	-	-	-	-	M	-	M	-
18LPE $26	L	H	-	-	H	M	H	L	-	-	-	L	-	M	-

L - Low, M - Moderate (Medium), H - High

18COE$01	CLIMATE CHANGE AND ADAPTATION *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- Able get knowledge about Climate system and its changes and causes
- Able to learn about impacts, adaptation and mitigation of climate change
- Able to learn about clean technology and clean energy

UNIT – I : EARTH'S CLIMATE SYSTEM	**(9 Periods)**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.	
UNIT – II : OBSERVED CHANGES AND ITS CAUSES	**(9 Periods)**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.	
UNIT – III : IMPACTS OF CLIMATE CHANGE	**(9 Periods)**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.	
UNIT – IV : CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES	**(9 Periods)**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry – Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) - Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.	
UNIT – V : CLEAN TECHNOLOGY AND ENERGY	**(9 Periods)**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology – Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.	

Contact periods:
Lecture: 45Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1 *Jan C. van Dam, **"Impacts of Climate Change and Climate Variability on Hydrological Regimes"**, Cambridge University Press, 2009.*
2 *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., **"Climate Change and Water"**. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 2008.*
3 *Dash Sushil Kumar, **"Climate Change – An Indian Perspective"**, Cambridge University Press India Pvt. Ltd, 2007.*
4 *IPCC Report Technical paper VI – Climate change and Water, 2008.*

REFERENCE BOOKS:

1 *IPCC fourth assessment report - The AR4 synthesis report, 2007*
2 *IPCC fourth assessment report –Working Group I Report, **"The physical Science Basis"**, 2007*
3 *IPCC fourth assessment report - Working Group II Report, **"Impacts, Adaptation and Vulnerability"**, 2007*
4 *Climate change 2014: Impacts, Adaptation and Vulnerability, IPCC*
5 *Climate change 2013: The Physical Science basis, IPCC.*
6 *www.environment.gov.au/climate-change/adaptation.*
7 *www.environment.org/explore-topics/climate-change/what.we.do/climate-adaptation.*

COURSE OUTCOMES:

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

CO1: Understand the climatic system and the factors influencing the climatic changes
CO2: Assess the uncertainty and impact of climatic changes
CO3: Understand the impacts of climate change in various sectors.
CO4: Develop strategies for adaptation and mitigation of climatic changes
CO5: Identify clean technologies for sustainable growth

COURSE ARTICULATION MATRIX:

PO / 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	PSO 1	PSO 2	PSO 3	PSO 4
CO1			M			L	L					L	L	L	L	L
CO2	L					L	L					L	M	M	M	L
CO3						L	L					L		H	H	
CO4	M	M	L	M		L	M					L	L	M	M	M
CO5	L	M	M	M		L	H					L	L	M	L	M
18COE $01	L	M	M	M		L	M					L	L	M	M	M

L-Low, M-Moderate (Medium), H-High

18COE$02	DISASTER MANAGEMENT AND MITIGATION *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To give knowledge about basics of Disaster Management.
- To impart knowledge about Hazards and Vulnerability.
- To give knowledge about mitigation and preparedness.
- To teach about Response and Recovery.
- To impart knowledge about the participants involved in the disaster management activity.

UNIT - I : INTRODUCTION	**(9 Periods)**
Disaster throughout history, History of disaster management, Capacity by demand, UN International strategy for disaster reduction, the Hyogo framework for action, Post 2015 framework, Disaster trends.	
UNIT – II : HAZARDS AND RISK VULNERABILITY	**(9 Periods)**
Hazard Identification and Hazard Profiling, hazard analysis, Types of hazards- Natural and technological Components of Risk- likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – purpose, Risk Acceptibility, Alternatives, Personnel. Political/ social, Economic. vulnerability-Physical Profile, Social Profile, Environmental Profile, Economic Profile. Factors Influncing Vulnerability, risk Perception.	
UNIT - III : MITIGATION AND PREPAREDNESS	**(9 Periods)**
Mitigation - types of mitigation ,Ostacles in mitigation, Assement and selection of Mitigation options, Emergency response capacity as , Incorporating Mitigation into development and relief projects. Prepareness- Government Preparedness, Public Preparedness, Media as a public educator. Obstacles to public education and preparedness.	
UNIT – IV : RESPONSE AND RECOVERY	**(9 Periods)**
Response the Emergency- Pre disaster, post disaster, Provision of water, food and shelter, volunteer management , command , control and coordination. Recovery- short term and long term recovery components of recovery- planning, coordination, information, money and supplies, allocation of relief funds, personnel. Types of recovery- Government, Infrastructure, Debris removal disposal and processing, environment, housing, economic and livelihood, individual, family and social recovery-special considerations in recovery.	
UNIT – V : PARTICIPANTS	**(9 Periods)**
Governmental Disaster management agencies- Fire, law, emergency management, Emergency medical service, Millitary and other resources. Structures- local, regional, national. Bilateral assistance and its types. Types of national agencies involved in international disaster management. Political implications of bilateral assistance. Non GovernmentalOrganaisations – operations, NGO/ Millitary coordination, standard of conduct. The role of Private sector and academia. Multilateral organaisations - UN agencies and progammes, Regional &Inernationalorganaisations. International Financial Institutions- the world bank, IMF, ADB, IADB. Special considerations.	

Contact periods:
Lecture: 45Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Damon P. Coppola,* ***"Introduction to International Disaster management"****, Elsevier publication, 2015*

REFERENCE BOOKS:

1. Brassard, Caroline, Giles, David W., Howitt, Arnold M., ***"Natural Disaster Management in the Asia-Pacific"****, Policy and Governance.*
2. ***"Disaster Management",*** *Global Challenges and Local Solutions, Universities Press, 2009.*
3. Jack Pinkowski, ***"Disaster Management Handbook"****, CRC Press , January 22, 2008.*
4. Disaster Management Guidelines, GOI-UNDP Disaster Risk Reduction Programme (2009-2012).

COURSE OUTCOME:

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

CO1: Able to get knowledge about basics of Disaster management.
CO2: Able to impact knowledge about Hazards and vulnerability
CO3: Able to know about Mitigation and preparedness.
CO4: Able to attain knowledge about response and recovery.
CO5: Able to learn about the participants involved in the disaster management activity.

COURSE ARTICULATION MATRIX:

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	PS01	PS02	PS03	PS04
CO1		L			L	L		L								L
CO2	L	H		M	L	M						L	L			L
CO3	L	L			H	M						L	L			L
CO4	L	M		L	L	M	M									L
CO5		M		L	L	M										L
18COE $02	L	M		L	L	M	M					L	L			L

L-Low, M-Moderate (Medium), H-High

18COE$03	ENERGY EFFICIENT BUILDINGS *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To understand the Concepts of Sustainable Environment, basics of energy analysis, simulation and management.
- To understand the concept of managing air quality.
- To understand the Green building concepts.

UNIT – I : INTRODUCTION	**(9 Periods)**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the environment -the sun-earth relationship and the energy balance on the earth's surface, climate, wind – solar radiation and solar temperature – sun shading and solar radiation on surfaces – energy impact on the shape and orientation of buildings – thermal properties of building materials.	
UNIT – II : ENERGY EFFICIENT TECHNIQUES	**(9 Periods)**
Passive Cooling And Day Lighting – Active Solar And Photovoltaic- Building Energy Analysis Methods- Building Energy Simulation- Building Energy Efficiency Standards- Lighting System Design- Lighting Economics and Aesthetics- Impacts of Lighting Efficiency – Energy Audit and Energy Targeting- Technological Options For Energy Management.	
UNIT – III : INDOOR ENVIRONMENTAL QUALITY MANAGEMENT	**(9 Periods)**
Psychrometry- Comfort Conditions- Thermal Comfort- Ventilation And Air Quality Air Conditioning Requirement- Visual Perception- Illumination Requirement- Auditory Requirement-Energy Management Options- Air Conditioning Systems- Energy Conservation In Pumps- Fans And Blowers-Refrigerating Machines- Heat Rejection Equipment- Energy Efficient Motors- Insulation.	
UNIT – IV : GREEN BUILDING CONCEPTS	**(9 Periods)**
Green Building Concept- Green Building Rating Tools- Leeds And IGBC Codes. – Material Selection Embodied Energy- Operating Energy- Façade Systems- Ventilation Systems- Transportation- Water Treatment Systems- Water Efficiency- Building Economics.	
UNIT – V : GREEN BUILDING DESIGN CASE STUDY	**(9 Periods)**
Students To Work Through A Controlled Process of Analysis And Design To Produce Drawings and Models Of Their Own Personal Green Building Project. Topics Include Building Form, Orientation and Site Considerations; Conservation Measures; Energy Modeling; Heating System And Fuel Choices; Renewable Energy Systems; Material Choices; and Construction Budget-Students Will Research Green Construction and Design in A Particular -Construction Context and Report Their Results to the Class.	

Contact periods:
Lecture: 45Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1 *Kibert, C.* ***"Sustainable Construction: Green Building Design and Delivery"****, John Wiley & Sons, 4th Edition, 2016.*

2 *Edward G Pita,* ***"An Energy Approach- Air-Conditioning Principles and Systems"****, Pearson Education, 2003.*

3 *Satyajit Ghosh, Abhinav Dhaka,* ***"Green structures: Energy efficient buildings"****, 2015.*

REFERENCE BOOKS:

1 *Colin Porteous,* ***"The New Eco-Architecture"****, Spon Press, 2002.*

2 *Ganesan T P,* ***"Energy Conservation in Buildings"****, ISTE Professional Center, Chennai, 1999.*

3 *NPTEL* ***"Energy Efficiency and Simulation"****, Prof.E.Rajsekar., IIT Roorkee.*

4 *Energy Conservation Building Codes: www.bee-india.nic.in*

5 *Lever More G J,* ***"Building Energy Management Systems"****, E And FN Spon, London, 2000.*

6 *NPTEL* ***"Energy efficiency acoustics and day lighting in building"****, Prof.B.Bhattacharjee., IIT Delhi.*

COURSE OUTCOMES:

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

CO1: Understand the Concepts of Sustainable Environment.

CO2: Understand the basics of energy analysis, simulation and management.

CO3: Understand the concept of managing air quality.

CO4: Understand the Green building concepts.

CO5: Create drawings and models of their own personal green building project

COURSE ARTICULATION MATRIX:

PO / 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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L	M	L			M	M	L	L	L		L	L	M	L	L
CO2			L	L		L	L					L		L		
CO3		L				L	M	L				L		L		
CO4	L	M					H					M		M		
CO5	M	M	H	L			H	L	M		M	M		H	L	M
18COE $03	L	M	H	L		M	H	L	L	L	M	M	L	H	L	M

L-Low, M-Moderate (Medium), H-High

18MOE$04	NANOTECHNOLOGY AND SURFACE ENGINEERING *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To Understand and analyze the concepts of Quantum confinement, Dimensional structures and Properties of Nanosystems
- To be familiar with various methods of synthesis of Nanomaterials
- To analyze and understand the mechanical and electrical properties of Nanomaterial and its applications

UNIT – I: PROPERTIES OF NANOMATERIALS	**(9 Periods)**
Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Properties of Individual nanoparticles. Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Top down and Bottom up approach.	
UNIT – II : SYNTHESIS OF NANOMATERIALS	**(9 Periods)**
Sol-Gel Process - Self-assembly – Electrodeposition - Spray Pyrolysis - Flame Pyrolysis – Metal nano-crystals by Reduction – Solvo-thermal Synthesis - Chemical Vapor Deposition (CVD) – Metal Orgonic Chemical Vapor Deposition (MOCVD).Ball Milling - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE) – Melt Spinning process – Applications	
UNIT – III : MECHANICAL AND ELECTRICAL PROPERTIES	**(9 Periods)**
Nanoscale Mechanics - Introduction – Mechanical properties – The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials –Plastic Deformation of Nanomaterials – Crystals and Crystal Plasticity – From Crystal Plasticity to Polycrystal Plasticity. Introduction - Energy Storage Basics - Electrical Energy Storage Devices and Impact of Nanomaterials - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls	
UNIT – IV : FUNDAMENTALS OF SURFACE ENGINEERING	**(9 Periods)**
Surface engineering - classification, definition, scope and general principles, Conventional surface engineering - Surface engineering by material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing, Surface engineering by material addition - From liquid bath, hot dipping, Electro-deposition / plating.	
UNIT – V : SURFACE MODIFICATION	**(9 Periods)**
Surface modification of steel and ferrous components - Pack carburizing, Aluminizing, calorizing, diffusional coatings (principle and scope of application), Surface modification using liquid/molten bath: Cyaniding, liquid carburizing (diffusion from liquid state), Surface modification using gaseous medium: Nitriding, Carbo-nitriding (diffusion from gaseous state).	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

1.Kelsall Robert W, Ian Hamley and Mark Geoghegan, ***—"Nanoscale Science and Technology"***‖, *Wiley Eastern, 2004.*

2.N John Dinardo, ***"Nanoscale Charecterisation of Surfaces & Interfaces****", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000*

3. *ASM Metals Hand Book –Vol. 5,* ***"Surface Engineering"****, 1996*

REFERENCE BOOKS:

1. *G. Timp. Editor,* ***"Nanotechnology"*** *AIP press, Springer-Verlag, New York, 1999*
2. *Hari Singh Nalwa, Editor,* ***"Nanostructured materials and Nanotechnology''****, Concise Edition, Academic Press, USA (2002).*
3. *GuozhongGao,****"Nanostructures & Nanomaterials: Synthesis, Properties & Applications****", Imperial College Press (2004).*
4. *K.G. Budinski,* ***"Surface Engineering for Wear Resistances",*** *Prentice Hall, Englewood Cliffs, 1988.*

COURSE OUTCOMES:

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

CO1: Analyze the particle size, particle shape, particle density, Size effect and properties of Nanostructures.

CO2: Acquire knowledge in various methods of synthesis of Nanomaterials.

CO3: Analyze the Elasticity of Nanomaterials, Electrical Energy Storage Devices and Aerogels.

CO4: Apply various Nanomaterials to the LED, Transistor Applications.

CO5: Apply various surface engineering techniques

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	M	L	M	M	M	L	M	M	M	M	M
CO2	H	H	M	H	H	L	L	M	M	M	L	H	M	H	M
CO3	H	H	L	H	M	M	L	L	M	M	M	M	M	H	M
CO4	L	H	M	H	M	M	L	L	M	M	M	M	M	H	M
CO5	M	M	L	M	M	L	M	M	M	L	M	M	M	H	M
18MOE$04	H	H	L	M	H	M	H	H	M	H	M	M	M	M	M

L-Low, M-Moderate(Medium), H-High

18MOE$05	**MECHATRONICS** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To study the mechatronics system and understanding the concepts of integration and design of mechatronics system.

UNIT – I : SYSTEM MODELS	**(9 Periods)**
Introduction - Definition of Mechanical Systems, Philosophy and approach. Systems and Design - Mechatronic approach, Integrated Product Design - Modeling- Analysis and Simulation, Man-Machine Interface.	
UNIT – II : SENSORS AND TRANSDUCERS	**(9 Periods)**
Sensors and transducers - classification, Development in Transducer technology, Optoelectronics - Shaft encoders, CD Sensors, Vision System.	
UNIT – III : DRIVES AND ACTUATORS	**(9 Periods)**
Drives and Actuators - Hydraulic and Pneumatic drives - Electrical Actuators - servo motor and Stepper motor, Drive circuits, open and closed loop control - Embedded Systems - Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.	
UNIT – IV : SMART MATERIALS	**(9 Periods)**
Smart materials - Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators - Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation.	
UNIT – V : MICROMECHATRONIC SYSTEMS	**(9 Periods)**
Micromechatronic systems - Microsensors, Microactuators - Micro-fabrication techniques - LIGA Process- Lithography, etching, Micro-joining. Application examples - Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.	

Contact Periods:
Lecture: 45Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

*1. W.Bolton, **"Mechatronics"**, Longman,2nd Edition,1999*

REFERENCE BOOKS:

1. *Michael B. Histand and David G.Alciatore, **"Introduction to Mechatronics and Measurement Systems"**, Tata McGraw Hill, 2nd Edition,2003*
2. *D.A.Bradley, D.Dawson, N.C.Buru and A.J.Loader, **"Mechatronics"** Chapman and Hall,1993*
3. *Dan S Necsulescu, **"Mechatronics"**, Pearson Education Asia,2005*
4. *Devdas Shetty, Richard A. Kolk, **"Mechatronics System Design"**, Thomson, PWS publishing, 2007.*
5. *Smaili.A and Mrad.F, "**Mechatronics: Integrated Technologies for Intelligent Machines**", Oxford university press, 2008*

COURSE OUTCOMES:

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

CO1: Identify the key elements of mechatronics system and models.

CO2: Select appropriate sensors and transducers for industrial application.

CO 3: Integrate mechanical, electrical, electronics, control systems in the mechatronics system design

CO 4: Select the proper smart material for mechatronics system.

CO 5: Apply the principles of mechatronics in industrial needs.

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	L	H	L	L	H	L	M	L	M	H	L
CO2	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO3	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO4	H	H	H	M	H	H	L	L	M	M	L	L	H	H	L
CO5	H	H	H	M	L	H	L	L	H	M	M	M	H	H	L
18MOE$05	H	H	H	H	L	H	L	L	M	L	M	L	M	H	L

L-Low, M-Moderate (Medium), H-High

18EOE$07	RENEWABLE POWER GENERATION SYSTEMS *(Common to All Branches)*

Category : OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To elucidate the technologies used for generation and utilization of power from renewable energy resources.

UNIT-I : SOLAR ENERGY	**(9 Periods)**
Solar radiation, solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions. Solar cells, PV systems, Standalone, Grid connected solar power - Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications -water heaters, dryers, stills, refrigeration, air-conditioning, solar pond, central receiver power generation.	
UNIT-II : WIND ENERGY	**(9 Periods)**
Wind energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application.	
UNIT-III : BIOMASS ENERGY	**(9 Periods)**
Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters - Fixed and floating digester biogas plants, economics of biomass power generation.	
UNIT-IV : OCEAN AND GEOTHERMAL ENERGY	**(9 Periods)**
Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Difference between tidal and wave power generation, Economics of OTEC. Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation.	
UNIT-V : RENEWABLE ENERGY POLICIES	**(9 Periods)**
Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuels mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy, and externalities. Cost assessment of supply technologies versus energy - Efficiency.	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Rao. S. and Dr. Pamlekar B.B "**Energy Technology**" Khanna Publishers, Second Ed. 2016*
2. *Rai , G.D., "**Non-Conventional sources of Energy**", Khanna Publishers , V Ed.,2016*

REFERENCE BOOKS:

1. *Khan. B.H, "Non-Conventional Energy Resources", The McGraw Hills, Second edition, 2016.*
2. *Bansal NK, Kleeman and Meliss, M "**Renewable Energy Sources and Conversion Techniques**", Tata McGraw Hill, 1996*
3. *Roland Wengenmayr, Thomas Buhrke," Renewable energy: Sustainable energy concepts for the future", Wiley-VCH, 1st edition, 2008.*

COURSE OUTCOMES:

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

CO1: Understand the concept of various Non-Conventional energy resources

CO2: Familiarize the principles of operation of renewable energy technologies

CO3: Realize the need for utilizing the energy from clean and Sustainable energy resources.

CO4: Interpret advantages and disadvantages of different renewable sources of energy

CO5: Comprehend the environmental aspects and the correlation between different operational parameters

CO6: Evaluate the options and estimate the energy generation through renewable sources

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	-	M	H	-	-	-	-	-	H	M	M
CO2	H	H	M	L	M	M	M	L	-	-	-	-	H	H	H
CO3	H	M	M	M	M	M	M	-	-	-	-	-	M	H	H
CO4	M	H	M	L	M	H	M	-	-	-	-	-	H	H	H
CO5	M	H	L	H	M	M	M	-	-	-	L	-	M	H	M
CO6	H	M	M	L	M	M	M	-	L	-	L	-	M	H	M
18EOE $07	H	H	M	M	-	M	M	L	L	-	L	-	H	H	H

L - Low, M - Moderate (Medium), H – High

18EOE$08	ELECTRIC VEHICLES *(Common to All Branches)*

Category : OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the technology of Electric and Hybrid Electric Vehicles and their business perspective

UNIT-I : INTRODUCTION	**(9 Periods)**
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	
UNIT-II : ELECTRIC TRAINS	**(9 Periods)**
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives- drive system efficiency.	
UNIT-III : ANALYSIS OF ENERGY STORAGE	**(9 Periods)**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	
UNIT-IV : ENERGY MANAGEMENT STRATEGIES	**(9 Periods)**
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	
UNIT-V : BUSINESS PERSPECTIVE OF ELECTRIC VEHICLE	**(9 Periods)**
Design of a Hybrid Electric Vehicle (HEV) - Design of a Battery Electric Vehicle (BEV) Hybrid Electric Heavy Duty Vehicles, Fuel Cell Heavy Duty Vehicles. Business: E-mobility business, electrification challenges, Connected mobility and Autonomous mobility- case study: E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "**Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design**", CRC press, 2004.*
2. *C. Mi, M. A. Masrur and D. W. Gao, "**Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives**", John Wiley & Sons, 2011.*
3. *S. Onori, L. Serrao and G. Rizzoni, "**Hybrid Electric Vehicles: Energy Management Strategies**", Springer, 2015.*

REFERENCE BOOKS:

1. *James Larminie and John Loury, "**Electric Vehicle Technology – Explained**", John Wiley & Sons Ltd, 2003.*
2. *Sandeep Dhameja, "**Electric Vehicle Battery Systems**", Butterworth – Heinemann, 2002.*
3. *Ronald K Jurgen, "**Electric and Hybrid – Electric Vehicles**", SAE, 2002.*
4. *Ron Hodkinson and John Fenton, "**Light Weight Electric/ Hybrid Vehicle Design**", Butterworth – Heinemann, 2001.*
5. *T. Denton, **"Electric and Hybrid Vehicles"**, Routledge, 2016.*

COURSE OUTCOMES:

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

CO1: Understand the basics of electric vehicle components and configuration.
CO2: Analyze suitable drive scheme for developing an electric vehicle.
CO3: Able to opt a proper energy management system.
CO4: Analyze the performance of practical HEV and EV.
CO5: Understand the infrastructure for Electric Vehicles and business potential.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO2	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO3	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO4	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO5	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
18EOE $08	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-

L - Low, M - Moderate (Medium), H – High

18EOE$09	SMART GRID SYSTEMS *(Common to All Branches)*

Category : OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

***** To comprehend the underlying techniques applied to Smart Grid

UNIT-I : BASICS OF POWER SYSTEMS	**(9 Periods)**
Basics of Power Systems: Load and Generation - Power Flow Analysis- Economic Dispatch and Unit Commitment Problems. Smart Grid: Definition – Applications- Government and Industry-Standardization	
UNIT-II : SMART GRID COMMUNICATIONS	**(9 Periods)**
Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure	
UNIT-III : WIDE AREA MEASUREMENT	**(9 Periods)**
Sensor Networks - Phasor Measurement Units- Communications Infrastructure- Fault Detection and Self-Healing Systems -Applications and Challenges	
UNIT-IV : SECURITY AND PRIVACY	**(9 Periods)**
Cyber Security Challenges in Smart Grid - Load Altering Attacks- False Data Injection Attacks-Defense Mechanisms - Privacy Challenges- Cyber Security Standards	
UNIT-V : ECONOMICS AND MARKET OPERATIONS	**(9 Periods)**
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process - Entities involved. The market place mechanisms-Energy and Reserve Markets- Market Power - Generation Firms- Locational Marginal Prices= Financial Transmission Rights	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

*1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage "**Smart Grid Technologies and applications"** John Wiley Publishers Ltd., 2012.*

*2. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "**Electrical Power Systems-Analysis, Security and Deregulation**" PHI Learning Private Limited, New Delhi, 2012.*

REFERENCE BOOKS:

*1. Lars T. Berger, Krzysztof Iniewski "**Smart Grid applications, Communications and Security**" John Wiley Publishers Ltd., 2012.*

*2.Yang Xiao, **"Communication and Networking in Smart Grids",** CRC Press Taylor and Francis Group, 2012.*

*3. Caitlin G. Elsworth, **"The Smart Grid and Electric Power Transmission"**, Nova Science Publishers Inc, August 2010.*

COURSE OUTCOMES:

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

CO1: Demonstrate the various aspects of the smart grid, including Technologies, Components, Architectures and applications

CO2: Creating a framework to operate the grid more effectively.

CO3: Evaluate the existing grid with respect to smart grid

CO4: Upgrade the existing grid to smart grid environment

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	-	-	L	L	M	H	L	M	M	M	H	M	H	M
CO2	L	L	M	M	M	M	M	L	M	M	M	M	M	M	H
CO3	-	-	-	M	M	M	M	M	M	M	M	H	M	M	M
CO4	L	-	-	M	M	M	H	-	M	M	M	H	M	H	H
18EOE $09	L	L	M	M	M	M	H	L	M	M	M	H	M	H	H

L - Low, M - Moderate (Medium), H - High

18LOE$10	**MOBILE COMMUNICATION** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study the concept of Mobile radio propagation, cellular system design
- To understand mobile technologies like GSM and CDMA.
- To know the mobile communication evolution of 2G, 3G and 3 GPP in detail.
- To have overview of immerging technologies application.

UNIT I WIRELESS COMMUNICATION	**(9 Periods)**
Cellular systems- Frequency Management and Channel Assignment- types of handoff and their characteristics, dropped call rates & their evaluation -MAC – SDMA – FDMA – TDMA – CDMA – Cellular Wireless Networks.	
UNIT II WIRELESS NETWORKS	**(9 Periods)**
Wireless LAN – IEEE 802.11 Standards – Architecture – Services – Mobile Ad hoc Networks- WiFi and WiMAX - Wireless Local Loop.	
UNIT III MOBILE COMMUNICATION SYSTEMS	**(9 Periods)**
GSM-architecture-Location tracking and call setup- Mobility management- Handover-Security-GSM SMS – International roaming for GSM- call recording functions-subscriber and service data mgt – Mobile Number portability -VoIP service for Mobile Networks – GPRS – Architecture-GPRS procedures-attach and detach procedures-PDP context procedure-combined RA/LA update procedures-Billing	
UNIT IV MOBILE NETWORK AND TRANSPORT LAYERS	**(9 Periods)**
Mobile IP – Dynamic Host Configuration Protocol-Mobile Ad Hoc Routing Protocols– Multicast routing-TCP over Wireless Networks – Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP- TCP over 2.5 / 3G wireless Networks.	
UNIT V APPLICATION LAYER	**(9 Periods)**
WAP Model- Mobile Location based services -WAP Gateway –WAP protocols – WAP user agent profile- caching model-wireless bearers for WAP - WML – WMLScripts - WTA - iMode - SyncML.	

Contact periods:
Lecture: 45 Periods **Tutorial:0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXT BOOKS:

*1. John Schiller, "**Mobile Communications**", Second Edition, Pearson Education, 2003.*
*2. William Stallings, "**Wireless Communications and Networks**", Pearson Education, 2002.*

REFERENCES BOOKS:

1. *Kaveh Pahlavan, Prasanth Krishnamoorthy, "**Principles of Wireless Networks**", First Edition, Pearson Education, 2003.*
2. *Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "**Principles of Mobile Computing**", Springer, 2003.*
3. *C.K.Toh, "**AdHoc Mobile Wireless Networks**", First Edition, Pearson Education, 2002.*

COURSE OUTCOMES:

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

CO1: Understand GSM, CDMA concepts and architecture, frame structure, system capacity, services provided.

CO2: Study of evolution of mobile communication generations 2G, 2.5G, 3G with their characteristics and limitations.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-
18LOE $10	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-

L - Low, M - Moderate (Medium), H - High

18LOE$11	INTRODUCTION TO VLSI SYSTEM DESIGN *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce various aspects of CMOS logic design in combinational and sequential circuit to design CMOS VLSI system components

UNIT I: CMOS LOGIC DESIGN	**(9 Periods)**
Inverter- CMOS Logic Gates: Compound Gates – Pass Transistors and Transmission Gates – Tristated – Multiplexers –CMOS Fabrication and Layout: Fabrication Process – Layout Design rule – Gate Layouts – Stick Diagrams – Design Partitioning	
UNIT II: MOS TRANSISTOR THEORY	**(9 Periods)**
Introduction – Long Channel I-V Characteristics – C-V Characteristics – Non-ideal I-V Effects – DC Transfer Characteristics – CMOS Technologies – Sources of Power Dissipation - Dynamic Power – Static Power.	
UNIT III: COMBINATIONAL CIRCUIT DESIGN	**(9 Periods)**
Circuit Families: Static CMOS – Ratioed Circuits – Cascode Voltage Switch Logic – Dynamic Circuits – Pass Transistor Circuits. Silicon-on-Insulator Circuit Design – Subthreshold Cirucit Design	
UNIT IV: SEQUENTIAL CIRCUIT DESIGN	**(9 Periods)**
Sequential static circuits – Circuit design of latched and flip-flops – Sequencing dynamic circuits – Synchronizers – Wave pipelining - VLSI clocking: CMOS clocking styles - Pipelined systems - Clock generation and distribution.	
UNIT V: DESIGN OF VLSI SYSTEMS	**(9 Periods)**
System Specifications – Structural Gate Level Modeling – Switch Level Modeling – Behavioral and RTL Modeling - Addition/subtraction – Comparators –counters —Multiplexers - Binary Decoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM – DRAM – ROM.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *N. Weste and David Money Harris, "**CMOS VLSI Design**", Fourth Edition, Pearson Education,2011.*
2. *Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*

REFERENCE BOOKS:

1. *Jan M. Rabaey, "**Digital Integrated Circuits: A Design Perspective**", PHI, Second Edition, 2012.*
2. *R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*
3. *Pucknell, "**Basic VLSI Design**", Prentice Hall, 2006.*

COURSE OUTCOMES:

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

CO1: Realize the CMOS logic design

CO2: Acquire knowledge on combinational and sequential circuit design of CMOS logic

CO3: Use VLSI clocking styles and realize CMOS VLSI system components

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LOE $11	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LOE$12	MICROCONTROLLER AND APPLICATIONS *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Describe the architecture of 8051 microcontroller.
- Develop assembly program for 8051.
- Apply the instruction set of 8051 to get effective programs.
- Design system in block level using microcontroller, memory devices, buses and other peripheral devices.
- Solve real life problem using microcontroller based systems.

UNIT I: MICROCONTROLLER	**(9 Periods)**
Microcontroller Features – On chip oscillator, List of Special Function Registers (SFRs), On chip program memory, on chip data memory, I/O Ports, Watch Dog Timer, Architecture of 8051, Instruction set - Addressing modes.	
UNIT II: ASSEMBLY LANGUAGE PROGRAMMING	**(9 Periods)**
8051 Assembly Language Programming, Branch Instruction Programming -I/O Port Programming – Arithmetic and Logic Instruction Programming-code conversion programming	
UNIT III: PROGRAMMING IN C AND INTERFACING-I	**(9 Periods)**
Timers & Counters programming - Serial Port Programming - Interrupts Programming .8255 Interfacing and Programming- External Memory Interfacing - LCD interfacing, LED Interfacing	
UNIT IV: INTERFACING-II	**(9 Periods)**
Keyboard Interfacing - ADC, DAC interfacing –Temperature Transducer-Pressure and Displacement Transducer-Light Sensor - Optocoupler - Relays.	
UNIT V: APPLICATIONS OF MICROCONTROLLERS	**(9 Periods)**
Stepper Motor interface-Temperature Monitoring and Control System-Speed Control of a DC Motor - Digital Thermometer-Digital Frequency Meter.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

*1.Mohammad Ali Mazidi, Janice Gillispie Mazidi **"The 8051 Microcontroller and Embedded Systems (Using assembly and C)"** Pearson education/ Prentice Hall of India Pvt. Ltd., 2007.*
*2. Ajit Pal, **"Microcontrollers : Principles and Applications"**, Prentice-Hall of India Pvt. Ltd; 1 edition (August 2011).*

REFERENCE BOOKS:

1. *Krishna Kanth, **"Microprocessor and Microcontroller Archotecture,Programming and System Design using 8085, 8086, 8051"**, Prentice Hall of India, 2011.*
2. *Kenneth J.Ayala, **"The 8051 Microcontroller"** 3rd edition,Thompson Delmar Learning,2007, New Delhi.*
3. *Jacob Fraden, **"Handbook of Modern Sensors: Physics, Design and Applications"**, 3rd ed, Springer, 2010.*
4. *Michael J. Pont, **"Embedded C"** Pearson Education India, 1st edition (2007);*

COURSE OUTCOMES:

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

CO1: Describe the architectures of controller

CO2: Develop Assembly program applying Digital logic and mathematics using 8051 instruction set

CO3: Design microcontroller based system within realistic constraint like user specification, availability of components etc

CO4: Interface real world sensors

CO5: Solve real life problem and construct a complete system as a solution

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO5	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
18LOE $12	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18POE$13	RAPID PROTOTYPING *(Common to All Branches)*

Category: OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of Rapid Prototyping technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications.

UNIT- I	INTRODUCTION	(9 Periods)
Need - Development of RP systems – Applications in Product Development - Virtual Prototyping- Rapid Tooling – Rapid Manufacturing - Classification of RP processes – Benefits - Applications		
UNIT- II	**REVERSE ENGINEERING AND CAD MODELING**	**(9 Periods)**
Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for RP- Case studies.		
UNIT- III	**LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Classification – Liquid based systems - Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and application. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.		
UNIT- IV	**POWDER BASED RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Selective Laser Sintering (SLS): Principle, process, indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications – case Studies, Selective Laser Melting and Electron Beam Melting		
UNIT- V	**OTHER RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, Demerits, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Bio Additive Manufacturing.		

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Chua Chee Kai and Leong Kah Fai* ***"Rapid Prototyping: Principles and Applications in Manufacturing",*** *John Wiley AND Sons, 1997*
2. *Paul F. Jacobs* ***"Stereo-lithography and other RP & M Technologies",*** *from Rapid Prototyping to Rapid Tooling, SME/ASME,1996*

REFERENCE BOOKS:

1. *Gibson, I., Rosen, D.W. and Stucker, B* ***"Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing",*** *Springer, 2010.*
2. *Chua, C.K., Leong K.F. and Lim C.S* ***"Rapid prototyping: Principles and applications",*** *second edition, World Scientific Publishers, 2010.*
3. *Gebhardt, A* ***"Rapid prototyping",*** *Hanser Gardener Publications, 2003.*
4. *Liou, L.W. and Liou, F.W* ***"Rapid Prototyping and Engineering applications: A tool box for prototype development",*** *CRC Press, 2011.*
5. *Hilton, P.D. and Jacobs, P.F* ***"Rapid Tooling: Technologies and Industrial Applications",*** *CRC press, 2005*

COURSE OUTCOMES:

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

CO1: Appreciate the importance of computers and modern tools in manufacturing to reduce cost and matching the societal needs.

CO2: Create and analyze 2D and 3D models using CAD modeling software and integrating with manufacturing systems.

CO3: Understand the variety of Additive Manufacturing (AM) technologies apply to their potential to support design and manufacturing, case studies relevant to mass customized manufacturing.

CO4: Apply knowledge on latest techniques of manufacturing in their field of career

CO5: To monitor and control shop floor with the aid of computers

COURSE ARTICULATION MATRIX

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			L				M						L	L	
CO2			M											M	L
CO3			L										M	L	
CO4			M		H	M	L						M	H	L
CO5		M				L					M		L	H	
18POE$13		M	M		M	L	L				L		M	M	L

L- Low, M – Moderate (Medium), H – High

18POE$14	MANAGERIAL ECONOMICS *(Common to All Branches)*

Category: OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To introduce the fundamental economic principles necessary for production managers.

UNIT- I	FUNDAMENTALS OF MANAGERIAL ECONOMICS	(9 Periods)
Goals and Constraints - The Nature and Importance of Profits - Understanding Incentives - Economic rationality, Scarcity and opportunity cost -Marginal and Incremental Analysis.		
UNIT- II	**DEMAND ANALYSIS**	**(9 Periods)**
Demand and Supply -Market Equilibrium - Price Elasticity of Demand - Price Elasticity, Total Revenue, and Marginal Revenue - Factors Affecting Price Elasticity - Cross Price Elasticity - Income Elasticity of Demand - Other Elasticities, Elasticities for Nonlinear Demand Functions - Elasticity of Supply.		
UNIT- III	**DEMAND THEORIES**	**(9 Periods)**
Choice and Utility Theory - Law of Diminishing marginal utility - Consumer Equilibrium - Consumer Surplus - Price effect, Substitution Effect and Income Effect.		
UNIT- IV	**THEORY OF PRODUCTION AND COST**	**(9 Periods)**
The Production Function - Profit-Maximizing Input Usage - Isoquants and Isocosts - Cost Minimization and Optimal Input Substitution - The Cost Function - Breakeven analysis, Contribution analysis - Long-run Costs and Economies of Scale - Multiple Cost Functions and Economies of Scope - Learning curve.		
UNIT- V	**THEORY OF MARKET AND PRICING**	**(9 Periods)**
The Nature of Industry - Perfect Competition – Monopoly - Monopolistic Competition – Oligopoly - Product pricing.		

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Thomas and Maurice **"Managerial Economics: Concept and Applications",** McGraw-Hill, 2005*
2. *Maheshwari.Y **"Managerial Economics",** Prentice Hall of India, 2012*

REFERENCE BOOKS:

1. *D.N. Dwivedi, **"Managerial Economics",** Vikas Publishing house, 2015*
2. *Christopher R Thomas, S Charles Maurice, **"Managerial economics",** Mcgraw Hill, 2014*

COURSE OUTCOMES:

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

CO1: Explain fundamentals of managerial economics.

CO2: Discuss the dynamics of market forces.

CO3: Explain about various theories of demand.

CO4: Discuss about the cost concepts related to production.

CO5: Describe about the theory of market and pricing method.

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	L	L							L	M	M	L			L
CO2	L	L	L							M	M	L			L
CO3	L									L	M	L			L
CO4	L									L	L	L			L
CO5	L	M	M	L						L	M	L			L
18POE$14	L	L	L	L						L	M	L			L

L- Low, M – Moderate (Medium), H - High

18POE$15	HYDRAULICS AND PNEUMATICS *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To make the students to design the hydraulic and pneumatic circuits for different applications.

UNIT- I	**BASIC PRINCIPLES**	**(9 Periods)**
Hydraulic Principles; Hydraulic Fluids; Hydraulic pumps – Classification, Characteristics, Pump Selection; Hydraulic actuators; Hydraulic valves – Pressure, Flow, Direction Controls, Applications, Symbols.		
UNIT- II	**HYDRAULIC CIRCUITS**	**(9 Periods)**
Hydraulic circuits – Reciprocating, Quick Return, Sequencing, Synchronizing, Regenerative circuit, Double pump hydraulic system; Safety Circuits.		
UNIT- III	**POWER GADGETS IN HYDRAULICS**	**(9 Periods)**
Accumulators – Classification, Circuits; Pressure Intensifier and Circuit; Mechanical-hydraulic servo system; Selection of components. Installation and Maintenance of Hydraulic power pack; Troubleshooting of fluid power circuits.		
UNIT- IV	**PNEUMATIC SYSTEMS**	**(9 Periods)**
Pneumatic Fundamentals; Control Elements; Logic Circuits; Position sensing, Pressure sensing; Electrical controls: Various switches; Electro Pneumatic and Electro Hydraulic Circuits.		
UNIT- V	**DESIGN AND SELECTION OF PNEUMATIC CIRCUITS**	**(9 Periods)**
Design of Pneumatic circuits – Classic, Cascade, Step counter; PLC and Microprocessors – Uses; Selection criteria for Pneumatic components; Installation and Maintenance of Pneumatic power pack; Fault finding; Case studies.		

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Anthony Esposito,* ***"Fluid Power with Applications",*** *Pearson Education India, 7th edition, 2013.*
2. *Andrew Parr,* ***"Hydraulics and Pneumatics:A Technician's and Engineer's Guide",*** *Butterworth-Heinemann, 3rd edition, 2011.*

REFERENCE BOOKS:

1. *DudleyA Pease and John J Pippenger* ***"Basic Fluid Power",*** *Prentice Hall PTR, 2nd edition 1987.*
2. *John J Pippenger and Tyler G Hicks* ***"Industrial Hydraulics",*** *McGraw Hill,2nd edition, 1970.*
3. *J. Michael, Pinches and HohnG.Ashby* ***"Power Hydraulics",*** *Prentice Hall, 1989.*

COURSE OUTCOMES:

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

CO1: Describe the principle of fluid power
CO2: Describe the components of hydraulics
CO3: Design the hydraulic circuits for automation
CO4: Describe the components of pneumatics
CO5: Design the pneumatic circuits for automation

COURSE ARTICULATION MATRIX

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	PSO 1	PSO 2	PSO 3
CO1	M	H										M			
CO2	M											M			
CO3	M	H										M			
CO4	M											M			
CO5	M											M			
18POE$15	M	H										M			

L- Low, M – Moderate (Medium), H - High

18NOE$16	MEASUREMENT AND CONTROL *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To learn about the working of different analog and digital instruments.

UNIT I – INTRODUCTION TO MEASUREMENTS	**(9 Periods)**
Significance of measurements – Methods of measurements – Classification of Instruments – Functions of Instruments and Measurement System – Elements of measurement system – Errors in measurement — Calibration of instruments: Methods & analysis – Introduction to Transducer & types.	
UNIT II – STRAIN AND DISPLACEMENT MEASUREMENT	**(9 Periods)**
Factors affecting strain measurements – Types of strain gauges – theory of operation – strain gauge materials – strain gauge circuits and applications of strain gauges. Resistive potentiometer (Linear, circular and helical) – L.V.D.T., R.V.D.T. and their characteristics – variable inductance and capacitance transducers – Piezo electrical transducers – Hall Effect devices and Proximity sensors.	
UNIT III – PRESSURE AND TEMPERATURE MEASUREMENT	**(9 Periods)**
Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement – Variable inductance and capacitance transducers – Piezo electric transducers – L.V.D.T. for measurement of pressure. Resistance type temperature sensors – RTD & Thermistor – Thermocouples & Thermopiles, Laws of thermocouple – Radiation methods of temperature measurement.	
UNIT IV – FLOW AND LEVEL MEASUREMENT	**(9 Periods)**
Differential pressure meters like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electromagnetic flow meter and Ultrasonic flow meter. Resistive, inductive and capacitive techniques for level measurement – Ultrasonic methods – Air purge system (Bubbler method).	
UNIT V – AUTOMATIC CONTROL SYSTEM	**(9 Periods)**
Elements of control systems – concept of open loop and closed loop systems – Controllers – Brief idea of proportional, derivative and integral – Pneumatic Controller – Hydraulic Controller.	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS

1. *A.K. Sawhney, Puneet Sawhney **"A Course in Electronic and Electrical Measurements and Instrumentation"** S.K.Kataria & Sons, Delhi, 2014.*
2. *E. D. Doeblin, **"Measurement Systems: Application and Design",** McGraw – Hill Publication, 6th Edition 2017.*

REFERENCE BOOKS

1. *S. K. Singh,* ***"Industrial Instrumentation & Control"****, 3rd Edition, McGraw Hill, 2016.*
2. *A.K. Sawhney, Puneet Sawhney* ***"A Course in mechanical measurements and Instrumentation & Control"****, Dhanapat Rai & Co, 2012.*

COURSE OUTCOMES:

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

CO 1: Explain the construction and working of instruments used for various measurements.
CO 2: Describe the methods of measurement, classification of transducers and to analyze error.
CO 3: Elaborate the basic concept of control system.
CO 4: Analyze the characteristics of various measuring instruments
CO 5: Suggest suitable instruments for a particular application

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO2	H	M	M	M	H	H	H	M	H	L	H	H	H	H	M
CO3	H	H	M	H	M	H	M	L	H	M	H	H	H	H	H
CO4	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO5	H	H	M	H	M	H	M	L	H	M	H	H	H	M	M
18NOE$16	H	H	M	H	M	H	M	L	H	M	H	H	M	H	M

L-Low, M-Moderate(medium), H-High

18NOE$17	**INDUSTRIAL AUTOMATION** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To elaborate the basic concept of automation and the components required for automation

UNIT I – INTRODUCTION TO AUTOMATION	**(9 Periods)**
Automation overview – requirement of automation systems – architecture of industrial automation system – power supplies and isolators –relays – switches –transducers – sensors –seal-in circuits – industrial bus systems : modbus and profibus.	
UNIT II – AUTOMATION COMPONENTS	**(9 Periods)**
Sensors for temperature – pressure – force – displacement - speed – flow- level – humidity and pH measurement. Actuators – process control valves – power electronic drives DIAC- TRIAC – power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control	
UNIT III – PROGRAMMABLE LOGIC CONTROLLERS	**(9 Periods)**
PLC Hardware – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.	
UNIT IV – DISTRIBUTED CONTROL SYSTEM (DCS)	**(9 Periods)**
Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers	
UNIT V – SCADA	**(9 Periods)**
Introduction - Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *John.W. Webb Ronald A Reis,* ***"Programmable Logic Controllers - Principles and Applications",*** *Prentice Hall Inc., 5th Edition, 2003.*
2. *M. P. Lukcas,* ***"Distributed Control Systems",*** *Van Nostrand Reinhold Co., 1986.*

REFERENCE BOOKS :

1. *Bela G Liptak,* ***"Process software and digital networks – Volume 3",*** *4th Edition, CRC press, 2012.*
2. *Romily Bowden,* ***"HART application guide and the OSI communication foundation",*** *1999*
3. *Frank D. Petruzella,* ***"Programmable Logic Controllers",*** *5th Edition, McGraw Hill, 2016.*

COURSE OUTCOMES:

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

CO 1: Elaborate the basic architecture of automation systems

CO 2 : Describe the various sensors and actuators involved in industrial automation

CO 3: Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications

CO 4: Illustrate the functionary components and supervisory control of DCS with relevant diagrams

CO 5: Describe the basics of SCADA technology

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
CO2	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO3	H	H	M	M	L	L	M	H	L	M	L	L	H	L	L
CO4	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO5	H	H	M	M	M	L	L	H	L	M	L	L	H	L	L
18NOE$17	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L

L-Low, M-Moderate(medium), H-High

18NOE$18	VIRTUAL INSTRUMENTATION *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To confer applications of virtual instrumentation in various fields.

UNIT I – INTRODUCTION	**(9 Periods)**
Virtual Instrumentation and LabVIEW - Evolution of LabVIEW - Difference between LabView and conventional languages - Sequencing and data flow - Graphical programming.	
UNIT II – LabVIEW ENVIRONMENT	**(9 Periods)**
Front panel - Block diagram - Icon and Connector - Control Palette - Function Palette-Tools Palette - Creating, editing, wiring, debugging and saving VIs - sub-VIs - creating sub-VIs - simple examples-Looping: For loop, while loop-Shift registers - case and sequence; structures, formula nodes.	
UNIT III – PROGRAMMING TECHNIQUES	**(9 Periods)**
Arrays - clusters, charts and graphs, - local and global variables - property node, string and file I/O.	
UNIT IV – DATA ACQUISITION AND INSTRUMENT CONTROL	**(9 Periods)**
DAQ – Components - Buffers: Buffered and non buffered I/O - Triggering - Analog I/O-Digital I/O - Counters and timers-Instrument control: VISA, GPIB, VXI and PXI	
UNIT V – ADVANCED Lab VIEW AND APPLICATIONS	**(9 Periods)**
Connectivity in LabVIEW: an introduction - IVI - Labwindows/CVI. Applications of Lab VIEW: process control, physical, biomedical, Image acquisition and processing.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Sanjay Gupta and Joseph John, **"Virtual Instrumentation using LabVIEW"** Tata McGraw-Hill, Second edition 2010*
2. *Gary Johnson, Richard Jennings **"Lab view graphical programming",** Tata McGraw Hill, 2011.*

REFERENCE BOOKS

1. *Lisa K Wells and Jeffrey Travels, **"Labview for everyone",** Prentice Hall, 3rd Edition 2009.*
2. *S. Gupta, J.P. Gupta, **"PC interfacing for data acquisition and process control",** 2nd Ed., Instrument Society of America, 2011*
3. *Jovitha Jerome, **"Virtual Instrumentation Using LabVIEW"** PHI Learning Pvt. Ltd 1st Edition, 2010*

COURSE OUTCOMES:

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

CO 1 Recognize the importance and applications of virtual instrumentation.

CO 2 Develop ability for programming in LabVIEW using various data structures, program structures, plotting the graphs and charts for system monitoring, processing and controlling.

CO 3 Realize the basics of interfacing and programming using related hardware.

CO 4 condition the acquired signal from the transducer to standard data formats

CO 5 Develop real time applications using LabVIEW

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	M	M	L	L	L	H	L	M	M	M	H	M	M
CO2		H	H	H	L	L	L	H	L	M	M	M	H	M	M
CO3		H	M	M	L	L	M	H	L	M	M	M	H	M	M
CO4		H	H	H	L	L	L	H	L	M	M	M	H	M	M
CO5		H	M	M	M	L	L	H	L	M	M	M	H	M	M
18NOE$18	M	H	M	M	L	L	L	H	L	M	M	M	H	M	M

L-Low, M-Moderate(medium), H-High

18SOE$19	**PROGRAMMING IN JAVA** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course the students will be familiar with:

- Basic programming constructs in java to develop simple object oriented programs.
- Exception handling, multi-threading and I/O programming
- Development of GUI applications
- Manipulation of images.
- Network Programming

UNIT – I : FUNDAMENTALS OF JAVA PROGRAMMING	**(9 Periods)**
History and Evolution of Java- Overview of java– Operators- Control Structures– Methods- Classes and Objects– Inheritance- Packages and Interfaces- Exception Handling.	
UNIT – II : THREADS , I/O AND STRING HANDLING	**(9 Periods)**
Multi threaded Programming– Enumeration- Auto boxing– Annotations- String Handling-Input/Output: Exploring java.io.	
UNIT – III : APPLETS AND EVENT HANDLING	**(9 Periods)**
Applet class- Event Handling. Introducing the AWT: working with windows- graphics and text- Using AWT controls- Layout Manager - menus.	
UNIT – IV : IMAGING AND DATABASE CONNECTIVITY	**(9 Periods)**
Imaging: Creating- loading and displaying- Image observer- Double buffering- Media tracker- Image producer– consumer– filters– animation- Java Database Connectivity.	
UNIT – V : NETWORKING	**(9 Periods)**
Networking – Remote Method Invocation – Java Beans –Java servlets	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Herbert Schildt, **"Java, The Complete Reference** ", Tata McGrawHill, Eighth Edition, 2011.*

REFERENCE BOOKS:

1. *Deitel .H.M and Deitel.P.J, **"Java: How to Program",** Pearson Education Asia, Eighth Edition 2010.*
2. *Lay.S&Horstmann Gary Cornell, **"Core Java Vol I",** Seventh Edition, The Sun Microsystems & press Java Series, 2005.*
3. *Lay.S&Horstmann Gary Cornell, **"Core Java Vol II",** Eighth Edition, The Sun Microsystems & press Java Series, 2008.*

COURSE OUTCOMES:

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

CO1: Write simple java programs using fundamental concepts of java like control structures, inheritance, packages, interfaces and exception handling. [**Usage]**

CO2: Write java program using multithreading and string handling. [**Usage]**

CO3: Develop GUI based applications using Applets. [**Usage]**

CO4: Write java programs to display and manipulation of graphical images. [**Usage]**

CO5: Establish database connectivity.[**Familiarity]**

CO6: Develop client server programs using RMI and servlets. [**Usage]**

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H		H	M	M				H	M	M	H	H	H
CO2	M	M	H		H	M	M				H	M	M	H	H	H
CO3	M	M	H		H	M	M				H	M	M	H	H	H
CO4	M	M	H		H	M	M				H	M	M	H	H	H
CO5	M	M	H		H	M	M				H	M	M	H	H	H
CO6	M	M	H		H	M	M				H	M	M	H	H	H
18SOE$19	M	M	H		H	M	M				H	M	M	H	H	H

L - Low, M - Moderate (Medium), H - High

18SOE$20	**CYBER SECURITY** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with:

- Cybercrime and cyber offenses
- Cybercrime using mobile devices.
- Tools and methods used in cybercrime.
- Legal perspectives of cybercrime.
- Fundamentals of computer forensics.

UNIT – I : INTRODUCTION TO CYBERCRIME AND CYBEROFFENSES	**(9 Periods)**
Cybercrime and Information Security - Classifications of Cybercrimes - The Legal Perspectives - Cybercrime and the Indian ITA 2000 - A Global Perspective on Cybercrimes - Plan of Attacks - Social Engineering – Cyberstalking - Cybercafe and Cybercrimes – Botnets - Attack Vector.	
UNIT – II : CYBERCRIME: MOBILE AND WIRELESS DEVICES	**(9 Periods)**
Proliferation of Mobile and Wireless Devices - Trends in Mobility - Credit Card Frauds in Mobile and Wireless Computing Era – Security challenges posed by mobile devices – registry setting for mobile devices – authentication service security – attacks on mobile/cell phones – Organizational measures for handling mobiles.	
UNIT – III : TOOLS AND METHODS USED IN CYBERCRIME	**(9 Periods)**
Proxy Servers and Anonymizers – Phishing - Password Cracking – Keyloggers – Spywares -Virus and Worms - Trojan Horses and Backdoors – Steganography - DoS and DDoS Attacks - SQL Injection - Attacks on Wireless Networks.	
UNIT – IV : CYBERCRIMES AND CYBERSECURITY: THE LEGAL PERSPECTIVES	**(9 Periods)**
Cyberlaws- The Indian Context - The Indian IT Act - Challenges to Indian Law and Cybercrime Scenario in India - Consequences of Not Addressing the Weakness in Information Technology Act - Digital Signatures and the Indian IT Act - Amendments to the Indian IT Act - Cybercrime and Punishment.	
UNIT – V : UNDERSTANDING COMPUTER FORENSICS	**(9 Periods)**
Digital Forensics - Forensics Analysis of E-Mail - Network Forensics - Forensics and Steganography - Forensics and Social Networking Sites - Challenges in Computer Forensics - Data Privacy Issues – Forensics Auditing – Antiforensics.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Nina Godbole and Sunit Belapur,* ***"Cyber Security Understanding Cyber Crimes, Compute Forensics and Legal Perspectives"****, Wiley India Publications, April, 2011.*

REFERENCE BOOKS:

1. *Robert Jones,* ***"Internet Forensics: Using Digital Evidence to Solve Computer Crime",*** *O"Reilly Media, October, 2005.*
2. *Chad Steel, "****Windows Forensics: The field guide for conducting corporate computer investigations****", Wiley India Publications, December, 2006.*

COURSE OUTCOMES:

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

CO1: Explain the fundamental concepts of cybercrime and cyberoffenses. **[Familiarity]**

CO2: Describe the cybercrimes occurred in mobile and wireless devices. **[Familiarity]**

CO3: Elaborate the methods used in cybercrime. **[Familiarity]**

CO4: Explain the laws for cybercrime and its respective punishments. **[Familiarity]**

CO5: Explain the forensics Analysis of E-Mail, Network and Social Networking Sites **[Familiarity]**

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	M	M	L	H	L	M				H	H	L	M	M
CO2	M	M	M	M	M	H	M	M				M	H	H	M	M
CO3	H	L	L	L	L	H	H	L				H	H	H	L	L
CO4	H	M	M	M	M	H	H	H				M	H	H	L	L
CO5	H	M	M	M	M	L	H	L				H	H	H	M	M
18SOE$20	H	M	M	M	M	H	H	M				H	H	H	M	M

L - Low, M - Moderate (Medium), H - High

18SOE$21	NETWORK ESSENTIALS *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Basic taxonomy and terminology of the computer networking
- Wireless networking
- Addressing and Routing
- Routing protocols
- Troubleshooting and security issues.

UNIT – I : INTRODUCTION	**(9 Periods)**
Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics.	
UNIT – II : WIRELESS NETWORKING	**(9 Periods)**
Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth- WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation.	
UNIT – III : ADDRESSING AND ROUTING FUNDAMENTALS	**(9 Periods)**
IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet.	
UNIT – IV : ROUTING PROTOCOLS	**(9 Periods)**
Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP, DNS - Analyzing Internet Traffic.	
UNIT – V : TROUBLESHOOTING AND NETWORK SECURITY	**(9 Periods)**
Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Jeffrey S.Beasley Piyasat Nilkaew **"Network Essentials"** 3rd Edition, Pearson, 2012*
2. *Larry L. Peterson and Bruce S. Davie **"Computer Networks, A Systems Approach"** 5th edition, Morgan Kaufmann Publishers Inc, 2011.*

REFERENCE BOOKS:

1. *Behrouz A.Ferouzan, **"Data Communications and Networking"**, 5th edition, Tata McGraw-Hill, 2012.*
2. *Andrew S. Tanenbaum, **"Computer networks"**, PHI, 5th edition 2011.*

COURSE OUTCOMES:

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

CO1: Identify topologies and types of Computer Networks and enumerate the layers of the OSI model and TCP/IP and Explain the functions of each layer **[Familiarity]**

CO2: Explain the significance of wireless networks and configure a Wireless LAN **[Assessment]**

CO3: Describe basic routing algorithms and network services. **[Familiarity]**

CO4: Troubleshoot the router and switch interface **[Usage]**

CO5: Analyze Campus Network data traffic **[Usage]**

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H	H	H	L	L	H	H	H	H	H	M	H	H	M
CO2	L	L	L	L	H	L	L	H	L	L	L	H	M	H	H	M
CO3	L	H	M	M	H	L	L	H	H	M	L	H	L	H	H	L
CO4	H	H	H	M	H	L	L	H	H	H	M	H	M	H	H	M
CO5	H	H	H	M	H	L	L	H	H	M	L	H	M	H	H	M
18SOE$21	M	H	H	M	H	L	L	H	H	L	M	H	M	H	H	M

L - Low, M - Moderate (Medium), H - High

18IOE$22	PROGRAMMING IN PYTHON *(Common to All Branches)*

PRE-REQUISITES: **Category: OE**

NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Data types and variables declaration.
- Control statements, Functions and the use of basic programming.
- List, dictionary and operations used in python.
- File and Exception handling.
- Object oriented programming and GUI development.

UNIT – I : INTRODUCTION	**(9 Periods)**
Introduction to Python - Setting up Python in OS – Python IDLE(write- edit- run- and save programs) – Strings - Numbers – Variables – simple I/O - Getting user input– Using String method– Converting values.	
UNIT – II : CONTROL STATEMENTS AND FUNCTIONS	**(9 Periods)**
Control statements – Random number generator- Branching and loops – Range functions- Functions –User defined functions- passing parameters- return function- working with global variables and constants.	
UNIT – III : LISTS AND DICTIONARIES	**(9 Periods)**
Lists – create- index- slice a list- Add and delete elements from a list- Append- Sort and reverse a list- nested sequences- Dictionaries – Create- add- delete from a Dictionary- Operations associated with pairs of data.	
UNIT – IV : FILES AND EXCEPTIONS	**(9 Periods)**
Files – Read from text files- Write to text files- Read and write more complex data- Exceptions – Intercept and handle errors during program's execution.	
UNIT – V : OBJECT ORIENTED PROGRAMMING AND GUI	**(9 Periods)**
Object oriented programming – Create objects of different classes in the same program- objects communication- complex object creation- derive new classes- existing class extension- override method- GUI – GUI toolkit- create and fill frames- create buttons- text entries and text boxes- create check buttons and radio buttons - case study – create a web page using GUI functionality.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Y. Daniel Liang,* ***"Introduction to Programming Using Python",*** *Pearson, 2013.*
2. *David I.Schneider,* ***"Introduction to programming using python",*** *person, 2015.*

REFERENCE BOOKS:

1. *Michael Dawson,* ***"Python Programming for the Absolute Beginner",*** *Premier Press, 2003.*
2. *Charles Dierbach,* ***"Introduction to Computer Science Using Python: A Computational Problem-Solving Focus",*** *Wiley Publications, 2012.*

COURSE OUTCOMES:

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

CO1: Use various data types. **[Understand]**

CO2: Use control statements and functions. **[Understand]**

CO3: Analyze the arrangement of data elements in Lists and Dictionary structures. **[Analyze]**

CO4: Handle exceptions and perform file operations**. [Understand]**

CO5: Develop application using object oriented programming and GUI. **[Analyze]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L		L	L		L	L			L		L	L
CO2	M	L		L	L		L	L			L		L	L
CO3	M	M	L	M	L		L	L			L		M	L
CO4	M	M	L	M	L		M	M			L		M	L
CO5	M	M	L	M	L		M	M			M	L	M	L
18IOE $22	**M**	**M**	**L**	**M**	**L**		**M**	**M**			**L**	**L**	**M**	**L**

L - Low, M - Moderate (Medium), H – High

18IOE$23	**BIG DATA SCIENCE** *(Common to All Branches)*

PRE-REQUISITES: **Category: OE**

NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Big Data and its characteristics.
- Technologies used for Big Data Storage and Analysis.
- Mining larger data streams.
- Concepts related to Link analysis and handle frequent data sets.

UNIT – I : THE FUNDAMENTALS OF BIG DATA	**(9 Periods)**
Understanding Big Data-Concepts and Technology-Big Data Characteristics-Types of data-Case Study-Business Motivation and Drivers for Big Data Adoption- Planning Considerations-Enterprise Technologies and Big Data Business Intelligence- OLTP-OLAP-Extract Transform Load-Data Warehouses-Data Mart-Traditional and Big Data BI-Case Study.	
UNIT – II : BIG DATA STORAGE AND PROCESSING	**(9 Periods)**
Big Data Storage Concepts- Clusters-File systems and Distributed File Systems-NoSQL- Sharding - Replication -Sharding and Replication-CAP Theorem-ACID-BASE-Case Study- Big Data Processing Concepts- Parallel Data Processing-Distributed Data Processing-Hadoop-Processing Workloads-Cluster-Processing in Batch mode-Processing in RealTime mode-Case study	
UNIT – III : BIG DATA STORAGE AND ANALYSIS TECHNOLOGY	**(9 Periods)**
Big Data Storage Technology: On-Disk Storage devices-NoSQL Databases-In-Memory Storage Devices-Case study, Big Data Analysis Techniques: Quantitative Analysis-Qualitative Analysis-Data Mining-Statistical Analysis-Machine Learning-Semantic Analysis-Visual Analysis-Case Study.	
UNIT – IV : MINING DATA STREAMS	**(9 Periods)**
The stream data model – Sampling data streams – counting distinct elements in a stream – Estimating moments. Finding similar items – Applications of nearest neighbor search – shingling of documents - similarity preservation – locality sensitive hashing- distance measures – methods for high degree similarity.	
UNIT – V : LINK ANALYSIS AND FREQUENT ITEMSETS	**(9 Periods)**
Link analysis – Page rank – Efficient computation of a page rank – topic sensitive page rank – link spam –Frequent datasets – the market basket model – Apriori algorithm – handling larger datasets in main memory –limited pass algorithm – counting frequent items in a stream.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Thomas Erl, WajidKhattak, and Paul Buhler,* ***"Big Data Fundamentals Concepts, Drivers & Techniques",*** *Prentice Hall,2015.*
2. *AnandRajaraman and Jeffrey David Ullman,* ***"Mining of Massive Datasets",*** *Cambridge University Press, 2012.*

REFERENCE BOOKS:

1. *Paul Zikopoulos, Chris Eaton, Paul Zikopoulos,* ***"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data",*** *McGraw Hill, 2011.*
2. *Frank J Ohlhorst,* ***"Big Data Analytics: Turning Big Data into Big Money",*** *Wiley and SAS Business Series, 2012.*
3. *Bill Franks,* ***"Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics",*** *Wiley and SAS Business Series, 2012.*
4. *Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch , James Giles, David Corrigan,* ***"Harness the Power of Big data – The big data platform",*** *McGraw Hill, 2012.*
5. *Colleen Mccue,* ***"Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis",*** *Elsevier, 2007*

COURSE OUTCOMES:

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

CO1: Understand the Big Data and usage in Enterprise Technologies. **[Understand]**

CO2: Store and Process Big Data using suitable Processing Methods. **[Understand]**

CO3: Handle Big Data using appropriate analysis Techniques. **[Analyze]**

CO4: Mine larger data streams using suitable algorithms. **[Understand]**

CO5: Rank pages and handle large data sets efficiently. **[Analyze]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	M	L	H	L							M	L
CO2	M				H			L				L	M	L
CO3		H			H							L	M	L
CO4	M	H	M		M							L	M	L
CO5	L	M	H									L	M	L
18IOE $23	**M**	**H**	**M**	**L**	**H**	**L**		**L**				**L**	**M**	**L**

L - Low, M - Moderate (Medium), H - High

18IOE$24	OBJECT ORIENTED PROGRAMMING USING C++ *(Common to All Branches)*

PRE-REQUISITES: **Category: OE**

NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Fundamentals of object oriented programming
- Classes and objects
- Concepts of overloading and type conversions
- Inheritance and Polymorphisms
- Files, templates and exception handling

UNIT – I : PRINCIPLES OF OBJECT ORIENTED PROGRAMMING	**(9 Periods)**
Basic concepts- benefits – applications of object oriented programming – beginning with C++ - tokens – expressions and control structures – C++ stream classes – Formatted and Unformatted I/O operations. Managing output with manipulators.	
UNIT – II : CLASSES AND OBJECTS	**(9 Periods)**
Introduction – specifying class – defining member functions – memory allocation constructors and destructors - parameterized, copy, default, dynamic and multiple constructors – destructors.	
UNIT – III : FUNCTIONS AND TYPE CONVERSIONS	**(9 Periods)**
Introduction – function prototyping call by reference – return by reference – inline function – recursion – friend function – function overloading – operator overloading – manipulation of strings using operators – type conversions.	
UNIT – IV : INHERITANCE AND POLYMORPHISM	**(9 Periods)**
Defining derived classes – single, multiple, multilevel, hierarchical and hybrid inheritance – virtual base classes – abstract base classes – nesting of classes - pointers – pointers to objects – this pointer – pointers to derived classes – virtual functions – pure virtual functions virtual constructors and destructors.	
UNIT – V : FILES AND TEMPLATES	**(9 Periods)**
Classes for file stream operations – opening and closing a file – detecting EOF – open file modes – file pointers and their manipulations – sequential I/O operations – updating and error handling of file. Class and function template – template with multiple parameters – overloading, member function and non-type template arguments-Exception handling.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Lafort Robert,* ***"Object oriented proframming in C++",*** *4th Edition.*
2. *E.Balagurusamy,* ***"Object oriented Programming with C++",*** *McGraw Hill Education Ltd, 7th Edition 2017.*

REFERENCE BOOKS:

1. *R.Rajaram,* ***"Object Oriented Programming and C++",*** *New Age International 2nd edition, 2013.*
2. *K.R. Venugopal, Rajkumar, T. Ravishankar,* ***"Mastering C++",*** *Tata McGraw Hill Education, 2nd edition, 2013.*
3. *Yashavant P. Kanetkar,* ***"Let us C++",*** *BPB Publications, 2nd edition 2003.*

COURSE OUTCOMES:

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

CO1: Understand the principles of object oriented programming. **[Understand]**
CO2: Develop programs using classes and objects. **[Analyze]**
CO3: Use functions and type conversions in programs. **[Understand]**
CO4: Apply inheritance and polymorphism to develop applications. **[Analyze]**
CO5: Use files, templates and handle exceptions. **[Understand]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	H	M			M						M	L
CO2	M	H	H	H			M						H	L
CO3	M	H	H	H			M						H	L
CO4	M	H	H	H			M						H	L
CO5	M	H	H	H			M						H	L
18IOE $24	M	H	H	H			M						H	L

L - Low, M - Moderate (Medium), H - High

18BOE$25	COMPUTATIONAL BIOLOGY *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Understand the basic concepts and role of computation in biological analysis
- Familiarize with sequence alignment methods
- Understand the machine learning tools used for biological analysis

UNIT – I : BASICS OF BIOLOGY	**(9 Periods)**
Biomolecules of life: Structure and Composition of DNA, RNA & Protein. Protein Structure basics-Primary, Secondary and tertiary Structure of protein.	
UNIT – II : BIOLOGICAL DATABASES	**(9 Periods)**
Concept of Relational database, Data archiving, Data mining, Primary databases-NCBI, EMBL, DDBJ; Structure databases-PDB	
UNIT – III : SEQUENCE ANALYSIS	**(9 Periods)**
Pairwise alignment tools-Dot matrix analysis, Dynamic programming-Smith Waterman and Needleman Wunsch algorithm ,Heuristic methods- BLAST,FASTA; Multiple sequence alignment methods-Progressive alignment (Clustal)	
UNIT – IV : STRUCTURE ANALYSIS AND DRUG DESIGN	**(9 Periods)**
Protein secondary prediction-Chou fasman method, GOR method; Tertiary structure prediction-Homology modelling, Introduction to Computer aided drug design.	
UNIT – V : MACHINE LEARNING	**(9 Periods)**
Genetic Algorithm, Neural networks, Artificial Intelligence, Hidden markov model -application in bioinformatics	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1.David W. Mount , **"Bioinformatics: Sequence and Genome Analysis"** , Cold Spring Harbor Laboratory Press, Second Edition, 2004*

*2. Arthur M. Lesk, **"Introduction to Bioinformatics"**, Oxford University Press, 2008.*

*3.Pierre Baldi, Soren Brunak. , **"Bioinformatics: The machine learning approach"**, MIT Press, 2001*

REFERENCE BOOKS:

*1. Andreas D. Baxevanis, **"Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins"**, Third edition; Wiley-Interscience, 2004.*

*2. Baxevanis A.D. and Oullette, B.F., **"A Practical Guide to the Analysis of Genes and Proteins"**, 2nd ed., John Wiley, 2002*

*3. David L. Nelson, Michael M. Cox., **"Lehninger: Principles of Biochemistry"**, Sixth edition, Freeman, W. H. & Co. Publisher, 2012.*

COURSE OUTCOMES:

Upon completion of the course the students will be able to

CO1: Understand the basic structure of Biological macromolecules

CO2: Acquire the knowledge of biological databases and its importance.

CO3: Perform pair wise and multiple sequence alignment

CO4: Predict the secondary and tertiary structure of proteins.

CO5: Understand the machine learning approaches in computational biology

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	L	L		L			M				L	
CO2	M	L	L	L					L			L	L	L
CO3	L		L			M			L			L	L	
CO4	M	M	L	M	M								M	
CO5		M		H	H	M	L		M				H	H
18BOE $25	M	M	L	M	M	M	L		M			L	M	H

L - Low, M-Moderate (Medium), H- High

18BOE$26	FUNDAMENTAL CONCEPTS OF BIOLOGY FOR ENGINEERS *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the basic functions of the cell and their mechanisms in transport process.
- To get familiarize human anatomy and physiology.
- To learn about microbes, immune system and biomolecules.
- To know the concepts of applied biology.

UNIT – I : BASICS OF CELL BIOLOGY	**(9 Periods)**
An overview of cells – origin and evolution of cells-cell theory-classification of cells – prokaryotic cells and eukaryotic cells; Structure of prokaryotic and eukaryotic cells and their organelles-comparison of prokaryotic and eukaryotic cells; Transport across membranes – diffusion - active and passive diffusion.	
UNIT – II : BASICS OF MICROBIOLOGY	**(9 Periods)**
Classification of microorganism-microscopic examination of microorganisms; Structural organization and multiplication of bacteria-viruses-algae and fungi; Microorganism used for the production of penicillin-alcohol and vitamin B-12.	
UNIT – III : HUMAN ANATOMY AND PHYSIOLOGY	**(9 Periods)**
Basics of human anatomy-tissues of the human body-epithelial-connective-nervous and muscular; Nervous system-Respiratory System-Circulatory system and Digestive system.	
UNIT – IV : BIO MOLECULES AND IMMUNE SYSTEM	**(9 Periods)**
Introduction to Biochemistry-classification-structure and properties of carbohydrates-proteins- lipids and nucleic acids; Innate and acquired immunity; Types of immune responses.	
UNIT – V : APPLIED BIOLOGY FOR ENGINEERS	**(9 Periods)**
Overview of biosensors - glucometer applications-medicine; Microarray analysis to diagnose the cancer; Microbial production of biofuels; Applications of stem cells.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. Darnell J, Lodish H, Baltimore D. **"Molecular Cell Biology"**, W.H.Freeman; 8th Edition, 2016.*

*2. Pelczar MJ, Chan ECS and Krein NR, **"Microbiology"**, Tata McGraw Hill, 5thEdition, New Delhi.2001.*

*3. Wulf Cruger and Anneliese Cruger, **"A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCE BOOKS:

1. *David L. Nelson and Michael M Cox, **"Lehninger's Principles of Biochemistry"**, Macmillan Worth Publisher, 4th edition, 2004.*
2. *Brain R.Eggins , **"Chemical Sensors and Biosensors"**, John Wiley & Sons, 2002.*
3. *Anton Moser, **"Bioprocess Technology, Kinetics and Reactors"**, Springer, Berlin (Verlag),1st edition, 1998*
4. *Kuby J, **"Immunology"**, WH Freeman & Co., 7th edition, 2013.*

COURSE OUTCOMES:

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

CO1: Understand the functions of cell and their structural organization
CO2: Describe the mechanisms and role of cell in immune system
CO3: Get familiarized biomolecules and human anatomy system
CO4: Illustrate the applications of microbes in industrial process
CO5: Apply the engineering concepts in biology

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	-	-	-	-	-	-	-	-	-	H	M
CO2	L	M	-	L	-	-	L	M	-	-	-	-	M	M
CO3	L	M	L	L	-	-	-	L	M	-	-	L	H	H
CO4	L	L	L	L	M	-	-	-	L	-	-	-	M	H
CO5	-	-	-	-	-	-	-	-	-	-	-	-	H	H
18BOE $26	L	M	L	L	M	-	L	M	M	-	-	L	H	H

L - Low, M-Moderate (Medium), H- High

18BOE$27	FUNDAMENTALS OF BIOENGINEERING *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To make the students aware of the overall industrial bioprocess.
- To understand the basic configuration and parts of a fermentor.
- To study the production of primary and secondary metabolites.
- To understand the production of modern biotechnology products.

UNIT I: INTRODUCTION TO INDUSTRIAL BIOPROCESS	**(9 Periods)**
Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess.	
UNIT II : FERMENTATION INDUSTRY	**(9 Periods)**
Overview of fermentation industry, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Types of fermentation – Solid state, submerged, batch, continuous, fed batch fermentation methods.	
UNIT III : PRODUCTION OF PRIMARY METABOLITES	**(9 Periods)**
A brief outline of processes for the production of some commercially important organic acids - Citric acid, lactic acid ,acetic acid; amino acids - glutamic acid, phenylalanine; ethanol.	
UNIT IV: PRODUCTION OF SECONDARY METABOLITES	**(9 Periods)**
Study of production processes for various classes of secondary metabolites: Antibiotics: beta lactams – penicillin and cephalosporin; aminoglycosides – streptomycin; macrolides - erythromycin, vitamin - B9, B12.	
UNIT V: PRODUCTS THROUGH MODERN BIOTECHNIQUES	**(9 Periods)**
Production of industrial enzymes - proteases, amylases, lipases; Production of single cell protein from wastes; biopreservatives – Bacterosin; biopolymers - xanthan gum and PHA. Industrial uses of enzymes in detergents, beverage and food.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Peter F. Stanbur., Stephen J. Hall., A. Whitake., **"Principles of Fermentation Technology"**, Science & Technology Books. 2007.*
2. *Presscott, S.C., Cecil G., Dun, **"Industrial Microbiology"**, Agrobios (India), 2005.*
3. *Casida, L.E., **"Industrial Microbiology"**, New Age International (P) Ltd, 1968.*

REFERENCE BOOK

1. *Crueger, W., Anneliese Cruege.,**"Biotechnology: A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, Edition 2, 2003.*
2. *Sathyanarayana, U., **"Biotechnology"**, Books and Allied (P) Ltd. Kolkata, 2005.*
3. *Ratledge C., Kristiansen B., **"Basic Biotechnology"**, Cambridge University Press, second Edition, 2001.*
4. *Michael J. Waites., **"Industrial Microbiology: An Introduction"**, Blackwell Publishing,2001.*

COURSE OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

CO1: Understand the basics of industrial bioprocess.
CO2: Explain the principle of a fermentation process and the chronological development of fermentation industry.
CO3: Understand the basic configuration of a fermentor and its ancillaries.
CO4: Learn the production of various primary and secondary metabolites.
CO5: Understand the production of biotechnological products.

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	H	-	-	-	-	-	-	-	-	-	M	-
CO2	H	M	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	H	H	M	M	M	-	L	H	-	-	-	-	H
CO4	H	L	L	-	-	L	-	L	-	-	-	-	-	H
CO5	H	M	H	L	M	-	-	L	-	-	-	-	-	H
18BOE $27	H	M	H	M	M	M	-	L	H	-	-	-	M	H

L- Low , M-Moderate(Medium), H- High

18LVA$01	SCIENCE OF CREATIVITY

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To understand the neurology of creativity and creativity in physics
- To apply the creativity in engineering education

UNIT I: NEUROLOGY OF CREATIVITY AND ENHANCEMENT	**(5 Periods)**
Creativity: Definitions and Overview –Temporal lobes – Frontal Lobes – IQ Neurotransmitters - Limbic System and Creativity – Neurobiological model – Enhancing Creativity –Breaking down the big problem – developing own scientific creativity.	
UNIT II: CREATIVITY IN THEORETICAL PHYSICS AND CHEMISTRY	**(5 Periods)**
Introduction - Focus on the essential to reveal the universal - FolLow the equations -Analogies to develop radically new equations - Chemists and creativity - A model for in-class research experiences.	
UNIT III: CREATIVE ENGINEERING DESIGN: THE MEANING OF CREATIVITY AND INNOVATION IN ENGINEERING	**(5 Periods)**
Introduction -Creativity needed in engineering design -Importance of creativity and innovation for engineers beginning in education -Creativity and meta-cognitive abilities in engineering education - Central themes specific to engineering creativity - Measurement needs for engineering creativity - Engineering creativity measures -Creative engineering design measure -Current measurement contributions - Validity - Engineering Measures - Importance of Creative Engineering Design to STEM - Creativity for increasing enrollment in STEM.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Christine Charyton - **"Creativity and Innovation among Science and Art"**, Springer, 2015.*
2. *R. Keith Sawyer, **"Explaining Creativity: The Science of Human Innovation",** 2nd Edition, Oxford, 2014.*

COURSE OUTCOMES:

Upon completion of this course, the students will have/ able to:

CO1 : Exposure to neurology of creativity and enhancement

CO2: Knowledge on creativity in theoretical physics

CO3: Creativity in engineering design

COURSE ARTICULATION MATRIX:

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
CO1	L	-	-	-	-	-	-	-	-	-	-	-
CO2	L	-	-	-	-	-	-	-	-	-	-	-
CO3	L	H	M	H	H	H	M	M	L	L	L	L
18LVA$01	L	H	H	H	H	H	H	H	H	H	H	H

L - Low, M - Moderate (Medium), H - High

18LVA$02	PERSONAL LEADERSHIP

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- This course enables the students to develop skills for personal leadership.

UNIT I: INTRODUCTION	**(5 Periods)**
Meaning of personal leadership – Benefits of personal leadership – Aspects of effective leadership - How to find leadership - Find your Motivation - Follow your Mantra - Follow your Values - Reach your Goals - Continually Learn and Grow - Build Long-Term Relationships.	
UNIT II: SKILLS AND STRATEGIES	**(5 Periods)**
Skill developments for practice of leadership - Traditional concepts of effective leadership - Current strategies for success in a personal business environment, and develop a personal plan to cultivate a durable, effective, personal leadership model.	
UNIT III: BELIEFS, BEHAVIORS AND TOOLS	**(5 Periods)**
Goals and Goal Setting – Beliefs – Mental models, Growth Vs Fixed Orientation, Optimism. Behaviors – Ingredients for growth, Handling disruptive emotions, Tapping intuition. Tools – Solitude, Affirmation and Visualization, Meditation.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

*1.Weiss, Joseph W. (2011) "**An Introduction to Leadership Diego: Bridge point Education"**, Inc.*

REFERENCE BOOKS:

*1.Loehr & Schwartz, "**The Power of Full Engagement", Free** Press 2003.*

*2.Orlick, **"In Pursuit of Excellence",** (4th Edition) 2008.*

COURSE OUTCOMES:

Upon completion of this course, the students will have/able to:

CO1: Build personal leadership.

CO2: Develop a skills and strategies.

CO3: Ability to handle disruptive emotions.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	H	-	-	-	-	-	-	-	L
CO2	-	-	-	-	-	-	M	-	-	-	-	-	-	-	L
CO3	-	-	-	-	-	L	M	-	-	-	-	-	-	-	L
18LVA $02	-	-	-	-	-	H	H	-	-	-	-	-	-	-	H

L - Low, M - Moderate (Medium), H - High

18LVA$03	SCRIPTING LANGUAGES

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce the basics of scripting languages
- To give an exposure in programming the PERL language.
- To give an exposure in programming the TCL and PYTHON languages.

UNIT I: INTRODUCTION	**(5 Periods)**
Scripts and Programs – Origin of Scripting – Characteristics of Scripting Languages –Uses of Scripting Languages – Web Scripting – Practical Extraction and Reporting Language(PERL)- Names and Values – Variables – Scalar Expressions – Control Structures, arrays, list, hashes, strings, pattern and regular expressions – subroutines.	
UNIT II: ADVANCED PERL	**(5 Periods)**
Finer points of looping – pack and unpack – file system – data structures, packages, modules, objects, interfacing to the operating system – Creating Internet ware applications – Dirty Hands Internet Programming – security Issues.	
UNIT III: TOOL COMMAND LANGUAGE(TCL) AND PYTHON	**(5 Periods)**
TCL Structure – syntax – Variables and Data in TCL –Advanced TCL –Nuts and Bolts – Internet Programming – Security Issues – C Interface – Tool kit(TK) – Visual Tool Kits – Fundamental Concepts of TK – Events and Binding – Introduction to Python language: syntax, statements, functions, Built-in-functions and Methods, Modules in python – Exception Handling – Integrated Web Applications in Python Systems – Web Application Framework.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *David Barron,* ***"The World of Scripting Languages",*** *Wiley Publications, 2000.*
2. *Steve Holden and David Beazley,* ***"Python Web Programming",*** *New Riders Publications, 2002.*

REFERENCE BOOKS:

1. *M.Lutz,* ***"Programming Python",*** *Fourth edition, O'Reilly media,2010.*
2. *Larry Wall, T.Christiansen and J.Orwant,* ***"Programming Perl",*** *Fourth edition ,O'Reilly,2012.*
3. *Ousterhout,* ***"Tcl and the Tk Tool kit",*** *Pearson Education, 2009.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: An exposure to the scripting languages.

CO2: The ability to design and implement the scripting languages like PERL and python.

CO3: Gained knowledge in TCL programming and web based applications.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	-	-	H	-	-	-	-	-	-	-	-	H	-
CO2	-	H	-	-	H	H	H	H	-	-	-	-	-	H	-
CO3	-	-	-	-	H	H	H	H	-	-	-	-	-	H	-
18LVA $03	H	H	-	-	H	H	H	H	-	-	-	-	-	H	-

L - Low, M - Moderate (Medium), H - High

18LVA$04	SOCIAL WORK

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To understand the objectives, theoretical foundations and methods of social work.
- To imbibe the principles, values and ethics of professional social work.
- To impart the Social Work Education in India

UNIT I: SOCIAL WORK	**(5 Periods)**
Definition, objectives and functions – Historical development of social work in India- Contexts of social work practice – Concepts related to social work – Social service, Social welfare, Social reform, Social policy, Social security, Social justice and Social development.	
UNIT II: THEORIES OF SOCIAL WORK	**(5 Periods)**
Ecological Systems Theory, Psychodynamic Theory, Social Learning Theory, Anti-oppressive social work, Strengths perspective, Radical social work, Task centred approach and Gandhian	
UNIT III: SOCIAL WORK AS A PROFESSION	**(5 Periods)**
Philosophy, values, principles and code of ethics of professional social work – Knowledge and Skills base of social work – Tenets of the social work profession. Social Work Education in India – Evolution, Nature and content of social work education – Fieldwork.	

Contact Periods:

Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

TEXT BOOKS:

1. *Chowdhry, Paul. (1992). Introduction to social work. New Delhi: Atma Ram and Sons*
2. *Bhattacharya, Sanjay. (2008). Social work psycho-social and health aspects. New Delhi: Deep and Deep Publications.*

REFERENCE BOOKS:

1. *Compton Beulah R. (1980). Introduction to social welfare and social work. Illinois: The Dosery Press.*
2. *Cox, David and Manohar Pawar. (2006). International social work. New Delhi: Vistar Publications.*
3. *Dasguta, S. (1967). Towards a philosophy of Social Work in India. New Delhi: Popular Book Services*
4. *Desai, Murali. (2002). Ideologies and social work (Historical and Contemporary Analysis), Jaipur : Rawat Publications.*
5. *Dubois, Brenda, Krogsrud, Karla, Micky - Third Edition. (1999). Social work - An empowering profession. London : Allyn and Bacon.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: An understanding on the concept, objectives, functions of social work

CO2: Understanding on the theoretical foundations and methods of social work.

CO3: In-depth understanding of social work education and field work practicum.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	-	-	L	-	-	-	-	-	L	M	-	-	H	M	L
CO2	-	-	M	-	-	-	-	-	L	M	-	-	H	M	L
CO3	-	-	L	-	-	-	-	-	L	M	-	-	M	H	L
18LVA $04	-	-	M	-	-	-	-	-	L	M	-	-	H	H	L

L - Low, M - Moderate (Medium), H - High

18LVA$05	ANDROID APPLICATION DEVELOPMENT

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce the basic Android tools.
- To provide conceptual understanding about the Android software development.
- To make the students, explore the Android applications.

UNIT I: ANDROID TOOLS AND BASICS	**(5 Periods)**
Android Software Development Kit(SDK) and Prerequisites – Components of SDK – Java type system – Idioms of Java programming – Ingredients of android application: Activities, Intents and tasks – Android application run time environment.	
UNIT II: ANDROID SOFTWARE DEVELOPMENT	**(5 Periods)**
Eclipse concept and Terminology – Eclipse views and Perspectives – Java coding in Eclipse – Eclipse and Android – The Android framework – Serialization – Android GUI architecture – Fragments and Multiplatform support – Drawing 2D and 3D Graphics.	
UNIT III: ANDROID APPLICATION	**(5 Periods)**
Framework for well-behaved application – Content providers – Exploring content providers – Multimedia: Playing and Recording of Audio and Video – Near Field Communication (NFC): Reading a tag, Writing to a tag, P2P mode – Gesture input.	

Contact Periods:

Lecture:15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

TEXT BOOKS:

1. *Zigurd Mednieks, Laird Dornin, G.Blake Meike, Masumi Nakamura,* ***"Programming Android"****, O'Reilly media, 2nd edition, 2012.*

REFERENCE BOOKS:

1. *Jonathan stark, Brian Jepson, Brian macdonald,* ***"Building android apps with HTML, CSS and Java script",*** *o'Reilly media 2010.*
2. *Marko Gargenta,* ***"Learning Android"****, O'Reilly media, 2nd edition 2014.*
3. *Wei-meng Lee,* ***"Android application development cook book",*** *Wrox, 2012.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: Acquired knowledge about the basics of Android tools.

CO2: Acquired knowledge about Android software development.

CO3: Gained knowledge about the Android applications.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
C01	H	-	-	-	H	H	H	M	M	M	-	-	-	M	-
C02	-	H	-	-	H	H	-	-	-	-	-	-	-	M	-
CO3	-	-	-	-	H	H	H	H	-	-	-	-	-	H	-
18LVA $05	H	H	-	-	H	H	H	H	M	M	-	-	-	M	-

L - Low, M - Moderate (Medium), H - High

18LVA$06	WEB DESIGNING

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce the concepts in Core Java.
- To illustrate the concepts in web designing.
- To provide conceptual understanding of server site programming.

UNIT I: INTRODUCTION TO CORE JAVA	**(5 Periods)**
Core JAVA- Operator, Data type, Variable, Arrays, Methods & Classes, Inheritance, Package and Interface, Exception Handling, Multithread programming, I/O, Java Applet, String handling, Event handling, Introduction to Abstract Windowing Toolkit (AWT), AWT controls, Layout managers.	
UNIT II: WEB PAGE DESIGNING	**(5 Periods)**
HTML: List, Table, Images, Frames, Forms, CSS, Document Type Definition (DTD), XML: DTD, XML schemes, Object Models, presenting and using XML, Using XML Processors: Document	
UNIT III: SERVER SITE PROGRAMMING	**(5 Periods)**
Introduction to Active Server Pages (ASP), Introduction to Java Server Page (JSP), JSP Application Design, JSP objects, Conditional Processing, Declaring variables and methods, Sharing data between JSP pages, Sharing Session and Application Data, Database Programming using JDBC, development of java beans in JSP.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Xavier, C, **"Web Technology and Design"**, New Age International, 2013.*
2. *Margaret Levine Young, **"The Complete Reference Internet"**, TM, 2nd edition, 2002.*

REFERENCE BOOKS:

1. *Deitel, **"Java for programmers"**, Pearson Education, 2nd edition, 2011.*
2. *Jessica Burdman, **"Collaborative Web Development"**, Addison Wesley publications,1999.*
3. *Horstmann, **"CoreJava"**, Addison Wesley,2015.*
4. *Bhave, **"Programming with Java"**, Pearson Education, 2008*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: An introduction to core java and web development strategies

CO2: Acquired knowledge about the web page designing.

CO3: A depth knowledge in server site programming.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	H	L	L	L	-	-	-	-	-	H	-
CO2	-	-	-	-	H	M	M	M	-	-	-	-	-	H	-
C03	-	-	-	-	H	L	L	L	-	-	-	-	-	H	-
18LVA $06	L	-	-	-	H	M	M	M	-	-	-	-	-	H	

L - Low, M - Moderate (Medium), H - High

18LVA$07	LONG TERM EVOLUTION

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To have knowledge on LTE network architecture and protocols.
- To understand the concepts of Transport Channel Processing
- To acquire knowledge on scheduling, resource allocation, data fLow and mobility management

UNIT I: OVERVIEW AND CHANNEL STRUCTURE OF LTE	**(5 Periods)**
Evolution of mobile broad band-Demand drivers for LTE-key requirements of LTE design-key enabling technologies and features of LTE-LTE network architecture-spectrum and migration plan for LTE-Radio interface protocols-Hierarchical channel structure of LTE-downlink OFDMA radio resources-uplink SC-FDMA radio resources.	
UNIT II: TRANSPORT CHANNEL PROCESSING	**(5 Periods)**
Downlink Transport Channel Processing overview-down link shared channels-downlink control channels-broad cast channels-multicast channels-downlink physical signals-uplink Transport Channel Processing overview - Up link shared channels-uplink control information-uplink reference channels-random access channels-H-ARQ in downlink and uplink.	
UNIT III: DATA FLOW, RADIO RESOURCE MANAGEMENT AND MOBILITY MANAGEMENT	**(5 Periods)**
Scheduling and resource allocation- scheduling for VoIP-PDCP-MAC/RLC-Mobility management-Intercell interference coordination.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Arunabha Ghosh, Jun Zhang , Jeffrey G. Andrews , Rias Muhamed* ***,"Fundamentals of LTE "*** *1st Edition by Prentice Hall*
2. *Christopher Cox* ***"An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications "*** *2nd Edition*

REFERENCE BOOKS:

1. *Erik Dahlman , Stefan Parkvall , Johan Skold* ***"4G: LTE/LTE-Advanced for Mobile Broadband"****1st Edition*
2. *Chris Johnson* ***"Long Term Evolution IN BULLETS",*** *2nd Edition*
3. *Martin Sauter* ***"From GSM to LTE-Advanced: An Introduction to Mobile Networks and Mobile Broadband"*** *2nd Edition*
4. *Stefania Sesia ,Issam Toufik , Matthew Baker* ***"LTE - The UMTS Long Term Evolution: From Theory to Practice "*** *2nd Edition*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1 : An in-depth knowledge on LTE network architecture and protocols

CO2 :An understanding of Downlink Transport and Uplink Transport Channel Processing

CO3: An exposure to data fLow and mobility management

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	H	M	-	-	H	-	-	-	-	H	H	M	L
CO2	L	M	L	M	-	-	L	-	-	-	-	H	H	M	L
CO3	L	L	H	M	-	-	H	-	-	-	-	H	M	H	L
18LVA $07	M	M	L	M	-	-	H	-	-	-	-	-	-	-	-

L - Low, M - Moderate (Medium), H - High

18LVA$08	AVIONICS

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To understand the basics of Avionics and Navigation systems.
- To gain knowledge on Satellite navigation systems and Auto piloting.

UNIT I: INTRODUCTION	**(5 Periods)**
Aircraft- Axes system - Parts - Importance and role of Avionics - System Interface with pilot - Aircraft state sensor systems - Navigation systems - External world sensor systems - Task automation systems. Avionics architecture evolution - Avionics Data buses.	
UNIT II: NAVIGATION SYSTEMS	**(5 Periods)**
Radio navigation - Inertial sensors - Gyroscopes, Accelerometers, Inertial navigation systems - Block Diagram - Platform and strap down INS - Satellite Navigation – GPS.	
UNIT III: AIR DATA SYSTEMS AND AUTOPILOT	**(5 Periods)**
Air data quantities - Altitude, Airspeed, Mach no., Vertical speed, Total Air temperature, Stall warning, Altitude warning - Autopilot - basic principles - Longitudinal and Lateral autopilot, Virtual cockpit.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Albert Helfrick.D, "**Principles of Avionics", Avionics communications Inc.,2004*
2. *Collinson,R.P.G, **"Introduction to Avionics", Chapman and Hall,1996.*

REFERENCE BOOKS:

1. *Middleton,D.H, **"Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd, England, 1989.***
2. *Spitzer, C.R. "**Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J.,USA 1993.***
3. *Spitzer, C.R, **"The Avionics Handbook", CR CPress, 2000.***
4. *Pallet, E.H.J, **"Aircraft Instruments and Integrated Systems", Longman Scientific.1996.***

COURSE OUTCOMES:

Upon completion of this course, the students will have

CO1 : Basic knowledge on Avionics and Navigation systems
CO2: Exposure to Radio and Satellite navigation systems
CO3: Knowledge on Air data systems and Aircraft display

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	-	-	-	H	L	L	L	-	-	-	-	-	H	-
CO2	-	-	-	-	H	M	M	M	-	-	-	-	-	H	-
CO3	-	-	-	-	H	L	L	L	-	-	-	-	-	H	-
18LVA $08	L	-	-	-	H	M	M	M	-	-	-	-	-	H	-

L - Low, M - Moderate (Medium), H - High

18LVA$09	MACHINE VISION

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To impart knowledge of Image processing and Machine Vision concepts
- To apply the learned concepts in Industrial applications and Manufacturing Engineering

UNIT I: INTRODUCTION	**(5 Periods)**
Nature of Vision - Advantages of Machine vision - Applications of machine vision - Image acquisition principles and Devices - Various lighting techniques - Key stages in Image Processing Techniques.	
UNIT II: 3D AND DYNAMIC VISION	**(5 Periods)**
3D vision basics - Photometric Stereo - Dynamic Vision - Segmentation using Motion and Moving camera Motion.	
UNIT III: MACHINE VISION APPLICATIONS	**(5 Periods)**
CONSIGHT I Vision controlled Robot system - National Bureau of standards vision system - SRI Industrial vision system - Image Processing techniques - Implementation through Image Processing software - MATLAB/OPENCV.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *E.R.Davies,* ***"Computer and Machine Vision, Theory, Algorithms and Practicalities"****, 4th edition, Academic Press, 2013.*

REFERENCE BOOKS:

1. *Ramesh Jain, Rangachar Kasturi, Brian G. Schunck,* ***"MACHINE VISION",*** *McGraw-Hill, Inc., ISBN 0-07-032018-7, 1995.*
2. *Rafel C.Gonzalez, Richard E.Woods, StevenL.Eddins,* ***"Digital Image Processing using MATLAB"****, 2nd Edition, Tata McGraw-Hill Education, 2010.*

COURSE OUTCOMES:

Upon completion of this course, the students will have

CO1 : Knowledge on Image processing and Machine vision concepts
CO2 : Understanding of 3D and Dynamic Vision
CO3 : Ability to apply Machine vision algorithms to Real time applications

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	M	L	H	L	-	-	-	-	-	-	-	L	-	-
CO2	M	M	L	H	-	-	-	-	-	-	-	-	L	-	-
CO3	L	M	L	H	L	M	-	-	-	-	-	-	L	H	-
18LVA $09	M	M	L	H	L	L	-	-	-	-	-	-	L	L	-

L - Low, M - Moderate (Medium), H - High

18LVA$10	MILLIMETER WAVE COMMUNICATION

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To learn the millimeter wave characteristics.
- To have in-depth knowledge on Millimeter wave transceivers.
- To study the concepts of Millimeter wave antennas.
- To understand the concepts of Advanced Beam steering and Beam Forming Technology.
- To acquire knowledge on MILLIMETER WAVE MIMO
- To study the Advanced diversity techniques

UNIT I: MILLIMETER WAVE CHARACTERISTICS & TRANSCEIVERS	**(5 Periods)**
Millimeter Wave Characteristics - Channel Performance at 60 GHz - Gigabit Wireless Communications Development of Millimeter Wave Standards - Coexistence with Wireless Backhaul.	
UNIT II: MILLIMETER WAVE TRANSCEIVERS	**(5 Periods)**
Millimeter wave transceivers- Millimeter Wave Link Budget - Transceiver Architecture - Transceiver Without Mixer -Receiver Without Local Oscillator - Millimeter Wave Calibration - Research Trend: Transceiver Siliconization.	
UNIT III: MILLIMETER WAVE ANTENNAS	**(5 Periods)**
Path Loss and Antenna Directivity - Antenna Beam width - Maximum Possible Gain-to-Q - Polarization - Beam Steering Antenna - Millimeter Wave Design Consideration Forming Technology.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Kao-Cheng Huang, Zhaocheng Wang, "**Millimeter wave communication systems",** John Wiley & Sons, Hoboken, New Jersey, 2011.*
2. *"**Millimeter Wave Wireless Communications"** by Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels and James N. Murdock 2014*

REFERENCE BOOKS:

1. *Su-Khiong Yong, Pengfei Xia and Alberto Valdes-Garcia, "**60GHz Technology for Gbps WLAN and WPAN: From Theory to Practice",** Wiley 2010*
2. *Jonathan Wells, **"Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications",** Artech House, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1 : Knowledge on millimeter wave characteristics.

CO2 : An in-depth knowledge on Millimeter wave transceivers.

CO3 : An Ability to design Millimeter wave antennas.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	H	M	-	-	H	-	-	-	-	H	H	M	L
CO2	L	M	L	M	-	-	L	-	-	-	-	M	L	M	L
CO3	L	L	H	M	-	-	H	-	-	-	-	H	M	H	L
18LVA $10	M	M	H	M	-	-	M	-	-	-	-	H	M	M	L

L - Low, M - Moderate (Medium), H - High

18LVA$11	TELEMATICS

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce the basic coding techniques in cellular communication.
- To educate the various protocols in IP telephony.
- To illustrate the concept of digital cellular system.

UNIT I: TELEPHONE SWITCHING	**(5 Periods)**
Evolution of telecommunication – Switching system, Dialing mechanism, Electronic switching, Digital switching system, Stored Program Control(SPC) configuration, Architectural features, Centralized and distributed SPC, Enhanced services.	
UNIT II: SWITCHING NETWORKS	**(5 Periods)**
Single stage and multistage switching network – Blocking probability: Lee's model for three stage – Time division time switching – Combinational switch ST, TS, STS, TST stages – Limitations of conventional mobile telephone system.	
UNIT III: DIGITAL CELLULAR SYSTEM AND IP TELEPHONY	**(5 Periods)**
GSM – Different call flow sequences in GSM – North American CDMA cellular – VOIP, Low level protocols – RTP/RTCP/UDP – Voice activity detection and discontinuous transmission – IP telephony protocols – H.323 standard – Session Initiation Protocol (SIP) – Gateway location protocol – QoS requirements – Resource reservation protocol architecture.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *V. S. Bagad,* ***"Telematics",*** *Technical publications, Pune, First edition 2009.*

REFERENCE BOOKS:

1. *Rappaport,T.S., "****Wireless Communications",*** *Pearson Education, 2nd Edition 2009.*
2. *Simon Haykins & Michael Moher,* ***"Modern Wireless Communications",*** *Pearson Education, 3rd Edition, 2007.*
3. *Vijay. K. Garg,* ***"Wireless Communication and Networking",*** *Morgan Kaufmann Publishers, 2007.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: The ability to understand the basics of telecommunication.

CO2: Acquired knowledge about the concepts of switching networks and telephony.

CO3: Acquired knowledge in the field of digital cellular system and protocols.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	-	-	-	-	-	-	-	-	-	-	-	H	-	-
CO2	H	-	-	-	-	M	M	M	-	-	-	-	H	-	-
CO3	-	-	-	-	H	-	-	-	-	-	-	-	H	-	-
18LVA $11	M	-	-	-	M	L	L	L	-	-	-	-	H	-	-

L - Low, M - Moderate (Medium), H - High

18LVA$12	E-COMMERCE SECURITY

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- This course enables the students to get exposed to various threats and issues in e-commerce security and the solutions for them.

UNIT I: INTRODUCTION	**(5 Periods)**
Security testing of an online banking service: The online banking system, The attack. Software security analysis – Data Gathering – Preliminary investigation, On-site visit, Analysis – Kickoff meeting, Investigation, Risk mitigation. The e-commerce security environment.	
UNIT II: ISSUES AND THREATS	**(5 Periods)**
Key dimensions of e-commerce security – Computer security – Classification of information assets – Basic security issues – Threats to e-commerce system: Threats to front-end system, back-end system, client-side, service-side and e-commerce transaction. Seven security threats to e-commerce	
UNIT III: SOLUTIONS FOR SECURITY THREATS	**(5 Periods)**
Solutions for e-commerce security system – Solutions for service-side and transaction security - Cryptography and Encryption –Public key cryptography – Digital certificates – Securing channels of communication – Developing an e-commerce security plan.	

Contact Periods:
Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Anup K. Ghosh **"E-Commerce Security and Privacy**", Springer science + Business Media, LLC, 2012.*
2. *Gordon E. Smith , **"Control and Security of E-Commerce",** John Wiley & Sons Inc, 2004.*

REFERENCE BOOKS:

1. *Amir Manzoor, **"E-Commerce: An Introduction",** LAP LAMBERT Academic Publishing,2010.*
2. *Jean D'AmourHabiyaremye and Jules Miller, **"E-Commerce Security Threats",** GRIN Verlag publisher, 2013.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: Knowledge on online banking system and its security.
CO2: In-depth knowledge on various issues and threats in security
CO3: Awareness to learn various solutions for security threats

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	-	-	-	-	M	-	-	-	-	-	-	M	-	-
CO2	M	-	-	-	-	-	L	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	H	-	L	-	-	-	-	L	-	L
18LVA $12	M	-	-	-	-	H	L	L	-	-	-	-	M	-	L

L - Low, M - Moderate (Medium), H - High

18LVA$13	SIMULATION TECHNIQUES

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce discrete-event simulation techniques, statistical analysis and random number generation
- To model real-world systems, implement the model as a computer program

UNIT I: DISCRETE-EVENT SYSTEM SIMULATION	**(5 Periods)**
Simulation - Simulation of Queueing Systems - General Principles - Concepts in Discrete-event Simulation – List Processing -Simulation Software (open source)	
UNIT II: STATISTICAL MODELS AND ANALYSIS OF SIMULATION DATA	**(5 Periods)**
Statistical Models in Simulation – Useful Statistical Models – Discrete and Continues Distributions –Poison Process - Queueing Models- Characteristics - Simulating queuing models –Verification and Validation of Simulation Models –Calibration of models.	
UNIT III: RANDOM NUMBERS	**(5 Periods)**
Random-Number Generation –Techniques for Generation – Tests - Random-Variate Generation – Inverse Transform Technique – Acceptance-Rejection Technique – Special Properties.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, "**Discrete-Event System Simulation**", 5th Edition, Prentice Hall, 2010*
2. *B.W. Kernighan and D.M. Ritchie, **"The C Programming Language"**, 2nd Edition, Prentice Hall, 2012*

COURSE OUTCOMES:

Upon completion of this course, the students will have/able to:

CO1 : Understand discrete-event simulation techniques, statistical analysis and random number generation

CO2 : Model real-world systems

CO3 : Implement the model as a computer program

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	-	-	-	-	M	-	-	-	-	-	-	M	-	-
CO2	M	-	-	-	-	-	L	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	H	-	L	-	-	-	-	L	-	L
18LVA $13	M	-	-	-	-	H	L	L	-	-	-	-	M	-	L

L - Low, M - Moderate (Medium), H - High

18LVA$14	CLOUD COMPUTING

PRE-REQUISITES: 18LPE$10 DATA COMMUNICATION NETWORKS **Category: VA**

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To learn about the concept of cloud and utility computing.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.

UNIT I: CLOUD COMPUTING AND VIRTUALIZATION	**(5 Periods)**
Introduction to Cloud Computing –Evolution of Cloud Computing –Cloud Characteristics - Basics of Virtualization- Implementation levels of Virtualization- Virtualization structures- Tools and mechanisms- Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization	
UNIT II: CLOUD INFRASTRUCTURES	**(5 Periods)**
Service Oriented Architecture — NIST Cloud Computing Reference Architecture – laaS – PaaS – SaaS – Types of Clouds – Cloud Storage –Design Challenges in Cloud – Peer-to-Peer Architecture.	
UNIT III: PROGRAMMING MODELS	**(5 Periods)**
Parallel and Distributed programming Paradigms – MapReduce – Hadoop – Mapping Applications – Google App Engine – Amazon AWS – Cloud Software Environments –Eucalyptus – Open Nebula – Open Stack- Cloud Security Overview.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *Kai Hwang, Geoffrey C Fox, Jack G Dongarra, **"Distributed and Cloud Computing, From Parallel Processing to the Internet of Things"**, Morgan Kaufmann Publishers, 2012*
2. *Toby Velte, Anthony Velte, Robert Elsenpeter, **"Cloud Computing - A Practical Approach",** Tata McGraw-Hill Education Pvt. Ltd.,1st Edition,2009*

REFERENCE BOOKS:

1. *James E. Smith, Ravi Nair, **"Virtual Machines: Versatile Platforms for Systems and Processes",** Elsevier/Morgan Kaufmann, 1st Edition, 2005.*
2. *Rajkumar Buyya, Christian Vecchiola, S.ThamaraiSelvi **, "Mastering Cloud Computing",** Mcgraw Hill, 1st Edition,2013.*
3. *George Reese, **"Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)",** O'Reilly, 1st Edition, 2009.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

CO1: Ability to understand the cloud computing and Virtualization

CO2: Ability to Identify the architecture, infrastructure and delivery models of cloud computing

CO3**:** Ability to understand the Cloud Programming Models

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	M		L	-	-	-	-	-	-	-	-	3	L	L
CO2	L	M	M	L	-	-	-	-	-	-	-	-	3	L	L
CO3	L	M	M	L	L	-	-	-	-	-	-	-	H	M	L
18LVA $14	L	M	M	L	L	-	-	-	-	-	-	-	H	L	L

L - Low, M - Moderate (Medium), H - High

18LVA$15	DESIGN OF POWER SUPPLIES

PRE-REQUISITES: 18LPC303 ELECTRON DEVICES AND CIRCUITS **Category: VA**

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- This course enables the students to learn the various blocks of power supply and protection circuits. It also helps them to gain practical knowledge in designing power supplies for a particular specification.

UNIT I: RECTIFIERS AND FILTERS	**(5 Periods)**
Design of power supply: Typical specifications, Concept of ideal power supply and Voltage regulation, Rectifier and filter design, Unregulated power supply with rectifiers and filters.	
UNIT II: VOLTAGE REGULATORS	**(5 Periods)**
Basic shunt regulator design, Series pass transistorized regulator, Variable output voltage regulator, Overload protection circuits for regulators - Heat-sink selection - Three terminal IC regulator, Design examples of IC based power supplies.	
UNIT III: SMPS AND CASE STUDY	**(5 Periods)**
Switched Mode Power Supply: Types, operation, waveforms and design, transformer design for power supplies, small signal analysis of DC-DC converters and closed loop control. Case study - Design of 5V DC power supply. Simulation and experimentation.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

1. *S.Salivahanan, N.Sureshkumar and A.Vallavaraj, "**Electronic Devices and Circuits**", 2nd Edition,Tata McGrawHill, 2008.*
2. *Allen Mottershead "**Electronic Devices and Circuits**", Prentice Hall of India, 2008.*

REFERENCE BOOKS:

1. *www.ti.com/lit/ml/slup224/slup224.pdf*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: An ability to use appropriate rectifiers and filters for a particular scenario.

CO2: Exposure to different types of voltage regulators.

CO3: Practical exposure to design of power supply with simulation and experimentation

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	L	-	-	-	-	M	-	-	-	-	-	-	M	-	-
CO2	M	-	-	-	-	-	L	-	-	-	-	-	M	-	-
CO3	-	-	-	-	-	H	-	L	-	-	-	-	L	-	L
18LVA $15	M	-	-	-	-	H	L	L	-	-	-	-	M	-	L

L - Low, M - Moderate (Medium), H - High

18LVA$16	DESIGN OF COMMUNICATION SYSTEMS

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

- To introduce the student to visualize and analyse the Digital Communication concepts using Software Defined Radio.

LIST OF EXPERIMENTS:

1. Design & Implementation of Digital Modulation & demodulation Techniques.
2. Design & Implementation of Synchronization techniques.
3. Design & Implementation of Channel Estimation & Equalization.
4. Design & Implementation of OFDM transmitter & receiver system.
5. Performance analysis of OFDM based MIMO system.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 30 Periods** **Total: 30 Periods**

REFERENCE BOOKS:

1. *Theodore S.Rappaport., **"Wireless Communications"**, 2nd edition, Pearson Education, 2002.*
2. *John Proakis, Masoud Saleh, **"Contemporary Communication Systems Using MATLAB"**, 3rd Edition, Cengage learning.*
3. *Robert W Heath, **"Digital Wireless communication: Physical layer exploration Lab using NI USRP"**, 2014.*

COURSE OUTCOMES:

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

CO1: Demonstrate their knowledge in base band signaling schemes through implementation of Digital Modulation & demodulation Techniques

CO2: Apply various channel estimation and equalization schemes & demonstrate their capabilities towards the improvement of the BER performance of communication system

CO3: Understand the effect of Synchronization

CO4: Simulate & validate the functional modules of a OFDM AND MIMO system

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO2	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	M	M	-	-	-	-	-	-	L	L	L	L
CO4	M	M	M	M	M	-	-	-	-	-	-	L	L	L	L
18LVA $16	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L

L - Low, M - Moderate (Medium), H - High

18LVA$17	**APTITUDE-I** *(Common to ECE & IT Branches)*

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- To improve aptitude, problem solving skills and reasoning ability of the student.
- To collectively solve problems in teams & group.

UNIT I: NUMBERS AND ARITHMETIC – I	**(5 Periods)**
Types and Properties of Numbers, LCM, GCD, Fractions and decimals, Surds. Percentages, Profit Loss, Simple Interest & Compound Interest, Clocks & calendars.	
UNIT II: ALGEBRA – I	**(5 Periods)**
Logarithms, Problems on ages.	
UNIT III: REASONING	**(5 Periods)**
Logical Reasoning, Analytical Reasoning.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

*1.Agarwal R.S – **"Quantitative Aptitude for Competitive Examinations"**, S.Chand Limited 2011*

REFERENCE BOOKS:

1. *Abhijit Guha, **"Quantitative Aptitude for Competitive Examinations"**, Tata McGraw Hill, 3rd Edition, 2011*
2. *Edgar Thrope, **"Test Of Reasoning for Competitive Examinations"**, Tata McGraw Hill, 4th Edition,2012*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: Problem solving skills and reasoning ability of the student

CO2: Ability to solve problems in teams & group.

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	-	M	-	-	-	-	-	M	M	L	L
CO2	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L
18LVA $17	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L

L - Low, M - Moderate (Medium), H - High

18LVA$18	APTITUDE-II *(Common to ECE & IT Branches)*

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- To improve aptitude, problem solving skills and reasoning ability of the student.
- To collectively solve problems in teams & group.

UNIT I: ARITHMETIC – II	**(5 Periods)**
Ratios & Proportions, Averages, Mixtures & Solutions. Time, Speed & Distance, Time & Work.	
UNIT II: ALGEBRA – II	**(5 Periods)**
Quadratic Equations, Linear equations & inequalities.	
UNIT III: MODERN MATHEMATICS	**(5 Periods)**
Sets & Functions, Sequences & Series, Data Interpretation, Data Sufficiency.	

Contact Periods:

Lecture:15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOKS:

*1.Agarwal R.S – **"Quantitative Aptitude for Competitive Examinations"**, S.Chand Limited 2011*

REFERENCE BOOKS:

*1. Abhijit Guha, **"Quantitative Aptitude for Competitive Examinations"**, Tata McGraw Hill, 3rd Edition, 2011*

*2.Edgar Thrope, **"Test Of Reasoning for Competitive Examinations"**, Tata McGraw Hill, 4th Edition, 2012*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: Problem solving skills and reasoning ability.

CO2: Ability to solve problems in teams & group**.**

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	-	M	-	-	-	-	-	M	M	L	L
CO2	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L
18LVA $18	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L

L - Low, M - Moderate (Medium), H – High

18LVA$19	**APTITUDE III** *(Common to ECE & IT Branches)*

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

* To enhance holistic development of students and improve their employability skills.

UNIT I:	**(5 Periods)**
Video Profile- Tech Talk / Area of Interest / Extempore / Company Profile.	
UNIT II:	**(5 Periods)**
Curriculum Vitae. Mock Interview.	
UNIT III:	**(5 Periods)**
Group Discussion / Case Study**.**	

Contact Periods:

Lecture:15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

REFERENCE BOOKS:

1. *P.N.Joshi , **"Group Discussion on current topics"**, Ukain.*
2. *Acy Jackson ,Kathleen Geckeis, **"How to prepare your Curriculum Vitae"**, TMH, 2003 .*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: Ability to communicate effectively.

CO2: Ability to improve their employability skills

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L	-	M	-	-	-	-	-	M	M	L	L
CO2	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L
18LVA $19	M	H	M	M	-	M	-	-	-	-	-	M	M	L	L

L - Low, M - Moderate (Medium), H - High

18LVA$20	MICROSTRIP ANTENNA DESIGN

Category: VA

PRE-REQUISITES: NIL

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To introduce the basic Microstrip Radiator models.
- To provide design experience of Microstrip antennas using mathematical equations.
- To make the students understand various feeding techniques

UNIT I: MICROSTRIP RADIATOR MODELS	**(5 Periods)**
Microstrip Transmission Lines – Microstrip Discontinuities – Microstrip Patch Transmission Line Model – Microstrip Patch Radiation Patterns – Microstrip Patch Cavity Model – Integral and Differential Equation Model.	
UNIT II: SINGLE MICROSTRIP ELEMENT DESIGN	**(5 Periods)**
Substrate Selection – Rectangular Element Analysis and Trade-off – Rectangular Element Design – Comparison to Measured Results – Rectangular Patch Radiation Patterns – Quarterwave Short circuited Patch – Patch with Cover Layer – Circular Patch Design.	
UNIT III: ADVANCED FEEDING TECHNIQUES	**(5 Periods)**
Listing of Computer Programs – Electromagnetically Coupled patches – Aperture Coupled Patches – Coplanar Waveguide fed Patches – Other types of Printed Circuit Antennas.	

Contact Periods:

Lecture:15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

TEXT BOOKS:

1. *Robert A. Sainati, "**CAD of Microstrip Antennas for Wireless Applications**", Artech House.*

REFERENCE BOOKS:

1. *Ramesh Garg, Prakash Bhartia et.al., "**Microstrip Antenna Design Handbook**", Artech House, 2010.*
2. *Constantine A. Balanis, "**Antenna Theory-Analysis and Design**", 3rd edition, Wiley-India, 2010.*
3. *John D Kraus, Ronald J Marhefka. "**Antenna and Wave Propagation**", 4th edition, Tata McGraw Hill,2010.*

COURSE OUTCOMES:

Upon completion of this course, the students will have:

CO1: In-depth knowledge about Microstrip antenna radiation mechanism.

CO2: An ability to design Transmission line model based rectangular and circular Microstrip Antenna Design.

CO3: An ability to justify the importance of Microstrip Antenna Feeding Techniques

COURSE ARTICULATION MATRIX:

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	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO2	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	M	M	-	-	-	-	-	-	L	L	L	L
18LVA $20	M	M	M	M	M	-	-	-	-	-	-	L	M	L	L

L - Low, M - Moderate (Medium), H - High