ESTD. 1939

KARNATAK LAW SOCIETY'S
GOGTE INSTITUTE OF TECHNOLOGY
"JNANA GANGA" UDYAMBAG, BELAGAVI-590008,
KARNATAKA, INDIA.
Approved by AICTE & UGC
Permanently Affiliated and Autonomous Institution Under
Visvesvaraya Technological University, Belagavi
www.git.edu

ESTD. 1979

2018-19 Scheme

Department: Electronics and Communication Engineering

Programme: B.E. (Electronics and Communication Engineering)

3rd to 8th Semester Scheme of Teaching and Examination

7th Semester Syllabus

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION

To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem-solving ability with an analytical and innovative mindset.

QUALITY POLICY

- Imparting value-added technical education with state-of-the-art technology in a congenial, disciplined and a research-oriented environment.
- Fostering cultural, ethical, moral and social values in the human resources of the institution.
- Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

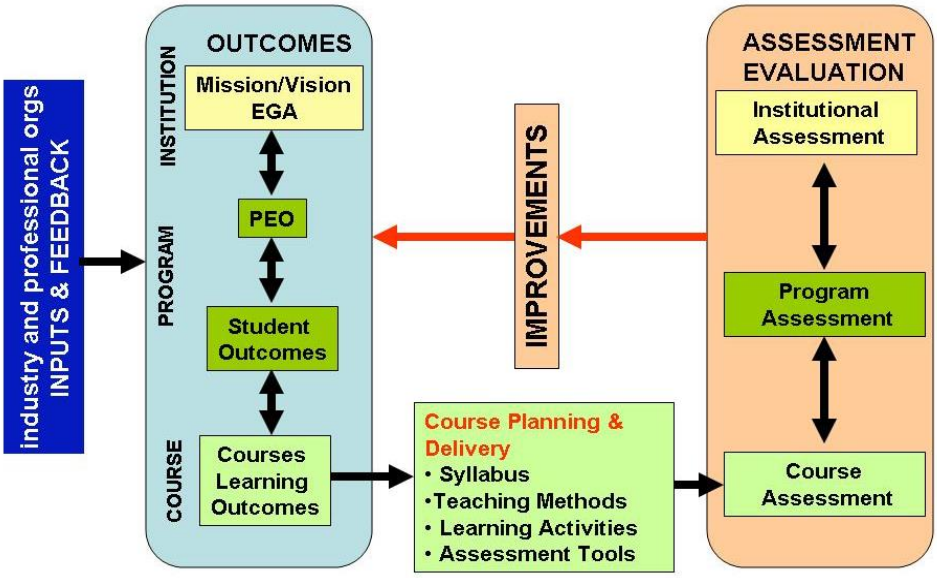
DEPARTMENT VISION

The Electronics & Communication Engineering department shall impart quality technical education and entrepreneurship skills to develop creative individuals to face changing global scenario.

MISSION

To augment the national talent pool, with Electronics and Communication Engineers having all-encompassing technical knowledge, principled practices and nationalistic outlook.

OUTCOME BASED EDUCATION (OBE)



PROGRAM OUTCOMES (POs):

National Board of Accreditation (NBA) has framed the Program Outcomes (PO) based on twelve Graduate Attributes (GA). These POs are generic to engineering education and applies to all branches of Engineering.

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

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

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

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

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

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

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

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

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

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

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

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

1. **The graduates will acquire core competence in basic science and Electronics and Communication Engineering fundamentals necessary to formulate, analyze, and solve engineering problems and to pursue advanced study or research.**
2. **The graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth and self-confidence to adapt to rapid and major changes.**
3. **The graduates will maintain high professionalism and ethical standards, effective oral and written communication skills, work as part of teams on multidisciplinary projects under diverse professional environments, and relate engineering issues to the society, global economy and to emerging technologies.**

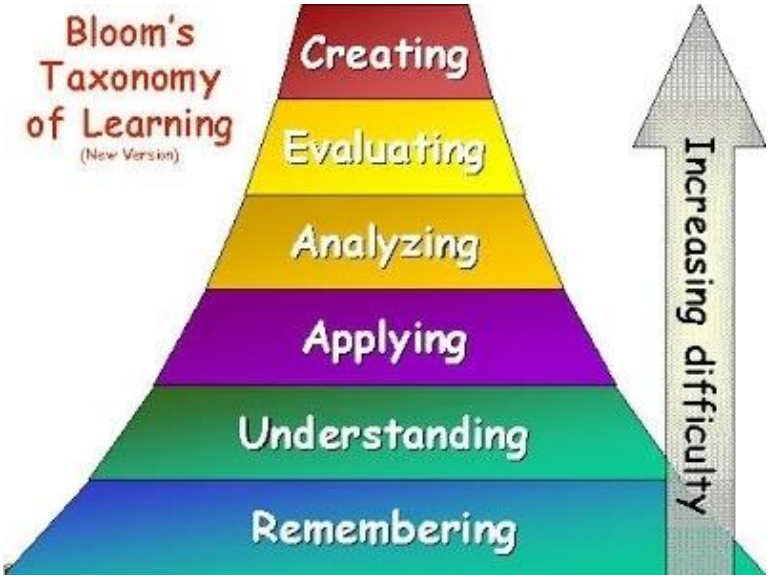
PROGRAM SPECIFIC OUTCOMES (PSOs):

1. **Understanding and applying the mathematical and scientific concepts, for analysis and design of basic Electronics and Communication systems.**
2. **Developing critical thinking abilities coupled with competence in use of computational tools for professional growth; complimented with communication skills and leadership attributes.**
3. **Identifying societal needs and sensitizing individuals towards finding innovative solutions to contemporary issues with multidisciplinary outlook.**

BLOOM'S TAXONOMY OF LEARNING OBJECTIVES

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 by Benjamin Bloom and modified during the 1990's by a new group of cognitive psychologists, led by Lorin Anderson (a former student of Bloom's) to make it relevant to the 21st century. The **revised taxonomy** given below emphasizes what a learner "Can Do".

Lower order thinking skills (LOTS)		
L1	Remembering	Retrieve relevant knowledge from memory.
L2	Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.
L3	Applying	Carry out or use a procedure in a given situation – using learned knowledge.
Higher order thinking skills (HOTS)		
L4	Analyzing	Break down knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.
L5	Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.
L6	Creating	Combining or reorganizing elements to form a coherent or functional whole or into a new pattern, structure or idea.



Scheme of Teaching and Examination- 3rd to 8th Semester B.E.

As per the guidelines of UGC CBCS the courses can be classified into:

i. **Core Courses (PC):** This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirements of a program in a said discipline of study. These courses will have 4 credits per course.

ii. **Foundation Courses:** The Foundation Courses are of two kinds:

   a. Compulsory Foundation (FC): These courses are the courses based upon the content that leads to Knowledge enhancement. These courses provide opportunities to improve technological knowledge before entering industry as well as preparing students for higher degrees in technological subjects. They are mandatory for all disciplines. These courses will have 4 credits per course.

The courses are: **Basic Science Courses (BS), Engineering Science Courses (ES).**

   b. **Foundation Electives (FE):** These are value-based courses aimed at man making education. These courses will have 3 credits per course. The course is related to **Humanities and Social Science Courses.**

iii. **Elective Courses:** This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills. These courses will have 3 credits per course.

An elective may be **Discipline Centric (PE)** or may be chosen from an unrelated discipline. It may be called an **Open Elective (OE).**

Mandatory Non-Credit Courses (MNC): These courses are mandatory for students joining B.E./B.Tech. Program and students have to successfully complete these courses before the completion of degree.

Semester wise distribution of credits for B.E program

Total credits for B.E Program: 175 credits

		Regular batch		**Dip. Lateral entry**	
	Semester	**Credits per Sem**	**Total credits**	**Credits per Sem**	**Total credits**
1st year	1	20	40	----	----
	2	20		----	
2nd year	3	24	48	24	48
	4	24		24	
3rd year	5	24	48	24	48
	6	24		24	
4th year	7	23	39	23	39
	8	16		16	
	Total	**175**	**175**	**135**	**135**

Credit definition:

Lecture (L): One Hour /week – 1 credit
Tutorial (T): Two hour /week – 1 credit
Practicals (P): Two hours /week – 1 credit;

Scheme of Teaching and Examination- 3rd to 8th Semester B.E.

Third Semester (Regular)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18MATEC31	Statistical-Numerical – Fourier Techniques	BS	4 – 0 – 0	4	4	50	50	100
2.	18EC32	Analog Electronics	PC1	4 – 0 – 0	4	4	50	50	100
3.	18EC33	Digital Electronics	PC2	4 – 0 – 0	4	4	50	50	100
4.	18EC34	Signals and Systems	PC3	3 – 2 – 0	5	4	50	50	100
5.	18EC35	Network Analysis	PC4	4 – 0 – 0	4	4	50	50	100
6.	18ECL36	Analog Electronics Lab	L1	0 – 0 – 3	3	1.5	25	25	50
7.	18ECL37	Digital Electronics Lab	L2	0 – 0 – 3	3	1.5	25	25	50
8.	18ECL38	Network Analysis Lab	L3	0 – 0 – 2	2	1	25	25	50
9.	18EC39	Environmental Studies	HS	MNC		MNC	25	-	25
		Total			**29**	**24**	**350**	**325**	**675**

Third Semester (Diploma)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18DMATEC31	Calculus, Fourier Analysis and Linear Algebra	BS	4 – 0 – 0	4	4	50	50	100
2.	18EC32	Analog Electronics	PC1	4 – 0 – 0	4	4	50	50	100
3.	18EC33	Digital Electronics	PC2	4 – 0 – 0	4	4	50	50	100
4.	18EC34	Signals and Systems	PC3	3 – 2 – 0	5	4	50	50	100
5.	18EC35	Network Analysis	PC4	4 – 0 – 0	4	4	50	50	100
6.	18ECL36	Analog Electronics Lab	L1	0 – 0 – 3	3	1.5	25	25	50
7.	18ECL37	Digital Electronics Lab	L2	0 – 0 – 3	3	1.5	25	25	50
8.	18ECL38	Network Analysis Lab	L3	0 – 0 – 2	2	1	25	25	50
9.	18EC39	Environmental Studies	HS	MNC		MNC	25	-	25
		Total			**29**	**24**	**350**	**325**	**675**

Forth Semester (Regular)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18MATEC41	Partial Differential Equations, Sampling Techniques and Transforms	BS	4 – 0 – 0	4	4	50	50	100
2.	18EC42	Microcontrollers	PC1	4 – 0 – 0	4	4	50	50	100
3.	18EC43	Control Systems	PC2	4 – 0 – 0	4	4	50	50	100
4.	18EC44	DSP & Algorithms	PC3	3 – 2 – 0	5	4	50	50	100
5.	18EC45	Communication Theory and Techniques	PC4	4 – 0 – 0	4	4	50	50	100
6.	18ECL46	Microcontrollers Lab	L1	0 – 0 – 2	2	1	25	25	50
7.	18ECL47	Communication Lab	L2	0 – 0 – 2	2	1	25	25	50
8.	18ECL48	Control System Lab	L3	0 – 0 – 2	2	1	25	25	50
9.	18ECB49/ 18ECS49	Balake Kannada/ Sanskrutika Kannada	HS	0 – 2 – 0	2	1	25	25	50
		Total			**30**	**24**	**350**	**350**	**700**

 # MNC: Mandatory Non-credit course. Pass in this course is mandatory for the award of degree.

Fourth Semester (Diploma)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18DMATEC41	Vector Calculus, Laplace Transforms and Probability	BS	4 – 0 – 0	4	4	50	50	100
2.	18EC42	Microcontrollers	PC1	4 – 0 – 0	4	4	50	50	100
3.	18EC43	Control Systems	PC2	4 – 0 – 0	4	4	50	50	100
4.	18EC44	DSP & Algorithms	PC3	3 – 2 – 0	5	4	50	50	100
5.	18EC45	Communication Theory and Techniques	PC4	4 – 0 – 0	4	4	50	50	100
6.	18ECL46	Microcontrollers Lab	L1	0 – 0 – 2	2	1	25	25	50
7.	18ECL47	Communication Lab	L2	0 – 0 – 2	2	1	25	25	50
8.	18ECL48	Control System Lab	L3	0 – 0 – 2	2	1	25	25	50
9.	18ECB49/ 18ECS49	Balake Kannada/ Sanskrutika Kannada	HS	0 – 2 – 0	2	1	25	25	50
		Total			**30**	**24**	**350**	**350**	**700**

Fifth Semester (Regular)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18EC51	Operating System**	PC1	3 – 2 – 0	5	4	50	50	100
2.	18EC52	CMOS VLSI Design	PC2	4 – 0 – 0	4	4	50	50	100
3.	18EC53	Information Theory and Digital Communication	PC3	4 – 0 – 0	4	4	50	50	100
4.	18EC54	Engineering Electromagnetics	PC4	3 – 2 – 0	5	4	50	50	100
5.	18EC55X	Professional Elective-I	PE	3 – 0 – 0	3	3	50	50	100
6.	**18EC56X**	**Open Elective – I Or Institute Elective**	OE	3 – 0 – 0	3	3	50	50	100
7.	18ECL57	VLSI Lab	L1	0 – 0 – 2	2	1	25	25	50
8.	18ECL58	Information Theory and Digital Communication Lab	L2	0 – 0 – 2	2	1	25	25	50
9.	18EC59A	Employability Skills – I	MNC	3 – 0 – 0	3	MNC	50	-	50
		Total			**31**	**24**	**400**	**350**	**750**

**** One Course of 4 credits exempted in 5th semesterfor Diploma lateral entry students to maintain the same credits as regular.**

Operating System has been exempted.

Course Code	Professional Elective – I
18EC551	Power Electronics
18EC552	System Modeling
18EC553	Speech Processing
18EC554	Artificial Neural Networks
18EC555	Cryptography and Network Security

Course Code	Open Elective – I
18EC561	Consumer Electronics
18EC562	Fuzzy Logic and Applications
18EC563	Heterogeneous Computing
18EC564	Requirements Engineering
18INT51 (Institute Elective)	**Biomedical Image Understanding and Analysis**

<u>Note:</u> Open Elective (OE) courses are offered to other branch students.

****However, institute elective can be opted by ECE students.**

Fifth Semester (Diploma)									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18DMATEC51	Partial Differential Equations, Z – Transforms and Stochastic Processes	BS	4 – 0 – 0	4	4	50	50	100
2.	18EC52	CMOS VLSI Design	PC1	4 – 0 – 0	4	4	50	50	100
3.	18EC53	Information Theory and Digital Communication	PC3	4 – 0 – 0	4	4	50	50	100
4.	18EC54	Engineering Electromagnetics	PC2	3 – 2 – 0	5	4	50	50	100
5.	18EC55X	Professional Elective-I	PE	3 – 0 – 0	3	3	50	50	100
6.	**18EC56X**	**Open Elective – I Or Institute Elective**	OE	3 – 0 – 0	3	3	50	50	100
7.	18ECL57	VLSI Lab	L1	0 – 0 – 2	2	1	25	25	50
8.	18ECL58	Information Theory and Digital Communication Lab	L2	0 – 0 – 2	2	1	25	25	50
9.	18EC59A	Employability Skills – I	MNC	3 – 0 – 0	3	MNC	50	-	50
10.	**18EC59B**	Communicative English	HS	1 – 0 – 1	2	MNC	25	-	25
		Total			**32**	**24**	**425**	**350**	**775**

**** One Course of 4 credits exempted in 5thsemester for Diploma lateral entry students to maintain the same credits as regular.**

Operating System has been exempted.

Course Code	**Professional Elective – I**
18EC551	Power Electronics
18EC552	System Modeling
18EC553	Speech Processing
18EC554	Artificial Neural Networks
18EC555	Cryptography and Network Security

Course Code	**Open Elective – I**
18EC561	Consumer Electronics
18EC562	Fuzzy Logic and Applications
18EC563	Heterogeneous Computing
18EC564	Requirements Engineering
18INT51 (Institute Elective)	**Biomedical Image Understanding and Analysis**

*****However, institute elective can be opted by ECE students.**

Sixth Semester									
S. No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18EC61	Image Processing and Computer Vision	PC1	3 – 2 – 0	5	4	50	50	100
2.	18EC62	Computer Communication Networks	PC2	4 – 0 – 0	4	4	50	50	100
3.	18EC63	Sensors and Signal Conditioning	PC3	3 – 2 – 0	5	4	50	50	100
4.	18EC64X	Professional Elective-II	PE	3 – 0 – 0	3	3	50	50	100
5.	18EC65X	Professional Elective-III	PE	3 – 0 – 0	3	3	50	50	100
6.	**18EC66X**	**Open Elective - II**	OE	3 – 0 – 0	3	3	50	50	100
7.	18ECL67	Advanced C and C++ Lab	L1	0 – 0 – 2	2	1	25	25	50
8.	18ECL68	Networking Lab	L2	0 – 0 – 2	2	1	25	25	50
9.	18EC69A	Constitution of India, PE and HV	HS	1 – 0 – 0	1	1	25	25	50
10.	18EC69B	Employability Skills – II	MNC	3 – 0 – 0	3	MNC	50	-	50
		Total			**31**	**24**	**425**	**375**	**800**

Course Code	**Professional Elective – II**
18EC641	Requirements Engineering
18EC642	Virtual Instrumentation
18EC643	Machine Learning
18EC644	Robotics & Automation
18EC645	Data Base Management System

Course Code	**Professional Elective – III**
18EC651	Digital Forensics
18EC652	Biomedical System Design
18EC653	Heterogeneous Computing
18EC654	Remote Sensing and GIS
18EC655	Human Computer Interaction
18EC656	Electric and Hybrid Vehicles

Course Code	**Open Elective - II**
18EC661	Nano Electronics
18EC662	Artificial Neural Networks
18EC663	Embedded System Design
18EC664	IoE

Seventh Semester									
S. No.	**Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18EC71	Management and Entrepreneurship With Branch specific case studies	HS	3 – 0 – 0	3	3	50	50	100
2.	18EC72	Microwave and Antenna Engineering	PC1	3 – 0 – 0	3	3	50	50	100
3.	18EC73	Wireless and Mobile Communication	PC2	3 – 0 – 0	3	3	50	50	100
4.	18EC74X	Professional Elective-IV	PE	3 – 0 – 0	3	3	50	50	100
5.	18EC75X	Professional Elective-V	PE	3 – 0 – 0	3	3	50	50	100
6.	**18EC76X**	**Open Elective - III**	OE	3 – 0 – 0	3	3	50	50	100
7.	18ECL77	Microwave and Antenna Lab	L1	0 – 0 – 3	3	1.5	25	25	50
8.	18ECL78	Wireless and Mobile Communication Lab	L2	0 – 0 – 3	3	1.5	25	25	50
9.	18EC79	**Seminar on Project synopsis (Design Thinking Approach) Project Phase -1**	**PC**	0 – 0 – 2	2	2	25	--	25
		Total			**26**	**23**	**375**	**350**	**725**

Project Phase -1: CIE- 25 marks (Average of 25 marks –Internal guide and 25 marks- presentation)

Course Code	Professional Elective – IV
18EC741	ASIC Design
18EC742	Analog Mixed Mode VLSI
18EC743	Electronic System Design
18EC744	RF System Design
18EC745	Deep Learning

Course Code	Professional Elective – V
18EC751	Low Power VLSI
18EC752	Multimedia Communication
18EC753	IoT
18EC754	Wireless Ad Hoc and Sensor Networks
18EC755	Data Analytics for Wearable Technology
18EC756	Salesforce Lightning (Integrated)
18EC757	AWS Cloud Computing (Integrated)

Course Code	Open Elective – III
18EC761	Sensors and Signal Conditioning
18EC762	Multimedia Processing
18EC763	System Modeling
18EC764	Digital Forensics
18EC765	Biomedical System Design
18EC766	Electric and Hybrid Vehicles

Eight Semester									
S. No.	**Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T – P			**CIE**	**SEE**	**Total**
1.	18EC81	Internship	PC			2	50	--	50
2.	18EC82	Intellectual Property Rights	HS	Self-Study		1	50		50
3.	18EC83	Professional Certification – 1(English / any other foreign language)	HS			1	25	--	25
4.	18EC84	Professional Certification – 2	PC			1	25	--	25
5.	18EC85	Project Phase – 2	PC			2	50(25+25)	--	50
6.	18EC86	Project Phase – 3	PC			4	50(25+25)	--	50
7.	18EC87	Project Phase – 4(Final Viva Voce)	PC	Final		5	--	100	100
						16	**250**	**100**	**350**

Internship: 6 to 8 weeks duration

Project Phase -2 and 3: CIE- 50 marks (25 marks –Internal guide + 25 marks- presentation)

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	**18EC71**	**Credits**	3
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	45	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Understand Characteristics and roles of management, Importance and Purpose of Planning, Organizing.
2. Understanding the Importance and Purpose of Staffing, directing and Controlling
3. Understand Meaning of entrepreneur, Development of Entrepreneurship and women entrepreneurs
4. Understand MSME's and various Central and State Institutional Supports.
5. Understand the concept of Project report and Business Proposals.

Unit – I 9 Hours

Management: Introduction, nature and characteristics of Management, Scope and Functional areas of management, Management as a science, art of profession

Planning: Nature, importance and purpose of planning process, Types of plans, Decision making, Importance of planning, steps in planning

Organizing: Nature and purpose of organization, Principles of organization, Types of organization (based on departments, based on commands), Span of control, MBO

Case Study: short case studies on organizational management and decisions in "Developments in Automotive Electronics"

Unit – II 9 Hours

Staffing, Directing & Controlling: Nature and importance of staffing, Process of Selection & Recruitment, Training Methods

Directing: Meaning and nature of directing, Leadership styles, Motivation Theories (McGregor's Theory of X and Y, Maslow's Hierarchy of needs theory, Herzberg's Motivation-Hygiene Theory), Communication- Meaning and importance

Controlling: Meaning and steps in controlling, Essentials of a sound control system, Methods of establishing control.

Case Study: short case studies on successful leaders like: Azim Premji, survey on work culture of Japanese for motivational theories.

Unit – III **9 Hours**

Entrepreneur: Meaning of entrepreneur: Evolution of the concept: Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Evolution of Entrepreneurship, The Entrepreneurial Culture and Stages in entrepreneurial process.

Case Study: Story of Entrepreneurs (Dhirubhai Ambani, NIRMA-Karjanbhai Patel), Women Entrepreneurs/ enterprises(e.g Kiran Majumdar Shaw, Mahila Griha Udyog Ltd Lijjat Papad)

Unit – IV **9 Hours**

Micro, Small and Medium Enterprises [MSMEs] and Institutional Support: Business environment in India**,** Role of MSMEs**,** Government policies towards MSMEs, Impact of Liberalization, Privatization and Globalization on MSMEs.

Institutional support: NSIC, TECKSOK, KIADB, KSSIDC, SIDBI; KSFC

Case Study: Belagavi District profile for MSME proposal, Preparation of a short proposal for funding for a MSME

Unit – V **9 Hours**

Preparation of Project report and Business Plan: Meaning of Project, Project Identification, Project Selection, Project Report, Need and Significance of Report, Contents.

Business Plan: Need of business plan, anatomy of business plan, executive summary, business description, Business environment analysis, background information.

Venture Capital: Meaning, Need, Types and Venture capital in India

Case Study: Story of Tesla's Electric Cars, report on successful start-up example SenseGiz.

Books

1. Henry Koontz, "Essentials of Management", McGraw Hill, 10th Edition 2017 onwards
2. Poornima.M.Charantimath, "Entrepreneurship Development", Pearson Education, 2014 Edition onwards

REFERENCES

1. P.C.Tripathi, P.N.Reddy "Principles of Management" — Tata McGraw Hill.
2. Dr.M.M.Munshi,Prakash Pinto and Ramesh Katri "Entrepreneurial Development" Himalaya Publishing House, 2016.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	To explain the Functions of management, Characteristics of Management, Importance and Purpose of Planning, organizing.	[L1]
2.	To explain Importance and Purpose of staffing, directing and controlling.	[L1, L2]
3.	To explain Meaning of entrepreneur, Development of Entrepreneurship and steps in developing entrepreneurship	[L2, L3]
4.	Describe the different Schemes and support for MSME's. and also Make In India, Start Up India, Digital India concepts.	[L2, L3]
5.	Propose a business plan and its report to the supporting institutions.	[L4]

Program Outcome of this course (POs) **PO No.**

1.	Ethics: Apply ethical Principles and commit to professional ethics and responsibilities and norms of engineering practice.	[PO8]
2.	Individual and Team work: function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.	[PO9]
3.	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.	[PO10]
4.	Project Management and Finance: demonstrate knowledge and understanding of engineering and management principles and apply these to once own work as a member and a leader in a team, to manage projects in multidisciplinary environment.	[PO11]

Course delivery methods	**Assessment methods**
1. Lecture	1. Quiz
2. Videos	2. IA
3. PPT	3. Assignment/case study presentation
4. Field study	4.

Scheme of Continuous Internal Evaluation (CIE):

Components	Total of two IA tests	**Average of assignments (Two) / activity/Presentation of Case Studies**	Class participation	Total Marks
Maximum Marks: 50	30	10	10	50

Case Studies will be evaluated during CIE (Assignments and IA tests) and 20% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass: 40**
3.	Question paper contains 08 questions each carrying 20 marks. Students have to answer FIVE full questions. SEE question paper will have two compulsory questions (any 2 units) and choice will be given in the remaining three units.

Microwave and Antenna Engineering

Course Code	18EC72	**Credits**	3
Course type	PC2	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Describe the microwave properties and its transmission media.
2. Describe microwave devices for several applications.
3. Understand the basics of antenna theory.
4. Select antennas for specific applications.

Pre-requisites:

1. Engineering Electromagnetics
2. Engineering Mathematics

Unit - I **8 Hours**

Microwave Transmission Lines: Microwave Frequencies and band designations (IEEE microwave frequency bands), Microwave devices, Microwave Systems, Transmission Line equations (derivation) and solutions (no derivation), Reflection Coefficient and Transmission Coefficient (no derivation), Standing Wave and Standing Wave Ratio, Smith Chart, Single Stub matching, double stub matching.

Case Study: Impedance matching of transmission line with the antenna as load.

Unit - II **8 Hours**

Microwave Network theory:

S matrix representation of Multi-Port Networks, Properties of S matrix, S parameters of a two-port network with mismatched load. (Text1: 6.1, 6.2, 6.3)

Microwave Passive Devices: Coaxial Connectors and Adapters, Attenuators, Phase Shifters, Waveguide Tees: E-plane, H-plane and Magic Tee, Isolators, Circulators, and Directional couplers.

Microwave Active Devices: Transferred Electron Device **(**TED), Gunn Diode.

Case Study: Microwave filter design using iris and windows.

Unit – III **8 Hours**

Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures, Effective Height, Bandwidth, Radio Communication Link, Antenna Field Zones & Polarization.

Strip Lines: Introduction, Micro Strip lines, Parallel Strip lines, Coplanar Strip lines, Shielded Strip Lines. (no derivations of equations, only numerical)

Case Study: Distributed antenna system (DIS) for IoT and Wireless applications.

Unit – IV **8 Hours**

Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of $n - Isotropic$ point sources of equal Amplitude and Spacing (array factor derivation).

Electric Dipoles: Introduction, Short Electric Dipole (no derivation), Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of $\lambda/2$ Antenna (no derivation).

Case Study: Design and simulation of microstrip dipole and patch antenna.

Unit - V **8 Hours**

Loop and Horn Antenna: Introduction, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Horn antennas, Rectangular Horn Antennas.

Case Study: Design and applications of Helical Antenna.

Books

Text Books:

1. Annapurna Das and Sisir K Das, "Microwave Engineering", TMH Publication, 2nd Edition, 2010 and onwards.
2. Liao, "Microwave Devices and circuits", Pearson Education.
3. John D. Krauss, "Antennas and Wave Propagation", 4th Edition, McGraw-Hill International, 2010 and onwards.

Reference Books:

1. David M. Pozar, "Microwave Engineering", John Wiley India Pvt. Ltd., 3rd Edition, 2008 and onwards.
2. C. A. Balanis, "Antenna Theory Analysis and Design", 3rd Edition, John Wiley India Pvt. Ltd., 2008 and onwards.

E-resourses(NPTEL/SWAYAM.. Any Other)- mention links

1. Antennas https://nptel.ac.in/courses/108/101/108101092/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain working of microwave transmission line and derive related equations.	L2
2.	Model and determine the performance characteristics of a microwave circuit.	L3
3.	Explain transmission line and waveguide structures and how they are used as elements in impedance matching and filter circuits.	L1
4.	Design antenna arrays of various types and evaluate radiation patterns.	L4
5.	Derive radiation mechanism and patterns of dipole, loop and patch antennas.	L3

Program Outcome of this course (POs) **PO No.**

1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**

Course delivery methods	**Assessment methods**
1. Blackboard Teaching	1. Internal Assessment
2. PPT's	2. Quiz
3. Videos	3. Assignment
4. Animations	4. Activity

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Wireless and Mobile Communication

Course Code	**18EC73**	**Credits**	3
Course type	PC3	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	50	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To enable the student to understand various generations of cellular communication.
2. To enable the student to understand cellular system components.
3. To enable the student to understand various modulation techniques used in wireless communication.
4. To enable the student to understand different irregularities introduced by channel and channel propagation models.
5. To enable the student to understand various emerging wireless technologies.

Pre-requisites: 1. Communication Theory and Techniques
2. Information Theory and Coding & Digital Communication

Unit - I **8 Hours**

Generations of wireless cellular networks:
1G- Introduction to AMPS characteristics, channels, system components and layout, typical AMPS operations, **2G-**introduction, general characteristics,**3G-**introduction, characteristics, radio interfaces, **4G-**wireless ATM, all-IP wireless networks, IEEE 802.02x.
Multiple access techniques: FDMA, TDMA, CDMA
Case Study: 5G, IoT

Unit – II **8 Hours**

Cellular system fundamentals:
Cellular network components- typical wireless cellular system components, subscriber device, base station system components, network switching system components, network management system, **Numbering schemes-**MSISDN, IMSI, IMEI, LAI, CGI, **The cellular concept-**hexagonal cell concept, advantage, reuse number, capacity expansion techniques, mobility management.

Unit - III **8 Hours**

Transmission techniques:
Modulation techniques- BPSK, DPSK, QPSK, BFSK, M-ary QAM, spread- spectrum.
Case Study: Multiplexing techniques: TDM, FDM, MIMO, OFDM

Unit – IV **8 Hours**

Wireless channel modeling:

Introduction to radio wave propagation, free wave propagation model, relating power to electric field, **Basic propagation mechanisms-Reflection**-reflection from dielectrics, Brewster angle, reflection from perfect conductors, ground reflection, **Diffraction**-Fresnel zone geometry, knife-edge diffraction model, multiple knife-edge diffraction, **Scattering-** radar cross section model, **Fading-** effects of fading, factors influencing fading, Doppler shift, types of fading.

Unit - V **8 Hours**

Short range wireless technologies:

Bluetooth, RFID, Zigbee, Near Field Communication (NFC), Wi-Fi, Wi-MAX, Wireless Access Point (WAP), Software Defined Radio/Cognitive Radio, LoRa.

Books

Text Books:

1. Gary J. Mullet, Introduction to wireless telecommunications systems and networks, Cengage learning, 2006.
2. Theodore S. Rappaport, Wireless Communications- Principles and Practice, Pearson, 2nd Ed, 2010.

Reference Books:

1. Jochen Schiller, Mobile Communications, Pearson Education, 2nd Ed, 2004.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand various generations of cellular communication.	L2
2.	Understand cellular system components	L3
3.	Understand various modulation techniques used in wireless communication.	L4
4.	Understand different irregularities introduced by channel and channel propagation models.	L4
5.	Understand various emerging wireless technologies.	L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**

5.	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	**7**
6.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	**12**

Course delivery methods	**Assessment methods**
1. Classroom Teaching (Blackboard)	1. IA test
2. Presentation	2. Assignment
3. Videos	3. Quiz
4. Notes	4. Mini Project

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

ASIC Design

Course Code	**18EC741**	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Explain ASIC methodologies, data path elements, logical effort.
2. Understand how programmable logic cells are used to implement a function on IC like MUX.
3. Analyse back-end physical design flow, including partitioning, floor-planning, placement and routing.
4. Gain sufficient theoretical knowledge for carrying out FPGA and ASIC designs.
5. Design CAD algorithms and explain how these concepts interact in ASIC.

Pre-requisites: CMOS VLSI Design

Unit – I **8 Hours**

Introduction to ASICs, Full custom, Semi-custom and programmable ASICs, ASIC design flow, ASIC cell libraries, CMOS logic, Datapath logic cells, Data path elements, Adders Carry skip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells.

Unit – II **8 Hours**

ASIC library design, Logical effort, Predicting delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages, Programmable ASIC Logic Cells, MUX as Boolean function generators, Actel ACT ACT1, ACT2 and ACT3 logic modules, Xilinx LCA XC3000 CLB, Altera FLEX and MAX.

Case Study: 1X/ 2X drive digital circuits analysis of Logical effort.

Unit – III **8 Hours**

Programmable ASIC I/O cells, Xilinx and Altera I/O block, Low-level design entry, Schematic entry, Hierarchical design, Netlist screener, ASIC construction, Physical design, CAD tools, Partitioning goals and objectives, Constructive partitioning, Iterative partitioning improvement, KL, FM and Look Ahead algorithms.

Case Study: Realization of partitioning algorithms (K-L algorithm).

Unit – IV **8 Hours**

Floorplanning and placement goals and objectives, Floorplanning tools, Channel definition, I/O and power planning and clock planning, Placement goals and objectives, Min-cut placement algorithm, Iterative placement improvement, Physical design flow.

Unit – V **8 Hours**

Routing**,** Global routing goals and objectives, Global routing methods, Back-annotation, Detailed routing goals and objectives, Measurement of channel density, Left-Edge and Area-Routing algorithms, Special routing, Circuit extraction and DRC.
Case Study: Design and simulation of routing algorithms.

Books

Text Books:

1. Michael John Sebastian Smith, "Application - Specific Integrated Circuits" Addison Wesley
   Professional, 2005 and onwards.
2. Rakesh Chadha**,** Bhasker J., "An ASIC Low Power Primer", Springer.

Reference Books:

1. Neil H.E. Weste, David Harris, and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", 3rd Edition, Addison Wesley/ Pearson education, 2011 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Describe the concepts of ASIC design methodology, data path elements, logical effort and FPGA architectures.	L2
2.	Design data path elements for ASIC cell libraries and compute optimum path delay	L2
3.	Illustrate the design of FPGAs and ASICs suitable for specific task, perform design entry to explain the physical design flow.	L3
4.	Create floorplan including partition, placement with the use of CAD algorithms.	L3
5.	Apply routing methods and analyse Power and Timing.	L3

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**2**
3.	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	**3**
4.	**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	**5**

Course delivery methods	**Assessment methods**
1. Presentation	1. Internal Assessment
2. Video	2. Quiz
3. Blackboard	3. Assignment
4.	4. Course Activity/ Mini-Project

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 45 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Analog Mixed Mode VLSI

Course Code	18EC742	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To understand the working of MOSFET amplifiers
2. To apply the knowledge of amplifiers to design differential amplifiers.
3. To study circuit analysis models of operational amplifiers.
4. To introduce to the fundamental concept of Data Converter
5. To provide insight into the architecture of Data Converter

Pre-requisites: Analog Electronics, Fundamentals of CMOS VLSI.

Unit – I **8 Hours**

Amplifiers: Gate-drain-connected loads, source follower, common gate amplifier, current source loads, cascade amplifier, common gate amplifier, push-pull amplifier
Case Study: Small signal analysis of common source amplifiers.

Unit – II **8 Hours**

Differential Amplifiers: Source-coupled pair, DC operation, AC operation, common mode rejection ratio, matching considerations, noise performance, slew-rate limitations, source cross-coupled pair, cascode loads (the telescopic diff-amp).
Case Study: Design and implementation of a differential amplifier for a given gain with resistive load.

Unit – III **8 Hours**

Operational Amplifiers: The two-stage op-amp, an op-amp with output buffer, the operational transconductance amplifier (OTA), gain-enhancement.
Case Study: Design an operational amplifier for a band of frequency.

Unit – IV **8 Hours**

Data Converter Fundamentals: Analog versus discrete time signals, converting analog signals to digital signals, sample-and-hold (S/H) characteristics, digital-to-analog converter (DAC) specifications, analog-to-digital converter (ADC) specifications, mixed-signal layout issues.
Case Study: Comparison of medium and high-speed analog digital converters.

Unit – V **8 Hours**

Data Converter Architectures: DAC architectures, current steering, current steering, ADC architectures-flash, the two-step flash ADC, the pipeline ADC, integrating ADCs.
Case Study: Comparison of pipeline, successive and interleaved architecture.

Books

Text Books:

1. R. Jacob Baker," CMOS Circuit Design Layout and Simulation",3rd Edition, A John Wiley & Sons, Inc., Publication
2. Phillip E. Allen, Douglas R. Holberg," CMOS analog circuit design", Oxford University Press. 2011.

Reference Books:

1. R. Jacob Baker, Harry W. Li, David E. Boyce, "MOS. Circuit Design, Layout and Simulation", Prentice-Hall of India Private Ltd., 2003.
2. Behzad Razavi," Design of Analog CMOS Integration Circuits", TATA McGraw - HILL Edition.

E-resourses (NPTEL/SWAYAM. Any Other)- mention links

1. https://nptel.ac.in/courses/117/101/117101105/
2. http://nptel.vtu.ac.in/econtent/courses/ECE/06EC63/index.php

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Demonstrate the ability to apply knowledge to understand MOSFET amplifiers	L2
2.	Analyze and design Differential CMOS amplifiers	L3
3.	Recognize the importance of Operational Amplifiers	L3
4.	Discuss the fundamentals Data Converters	L2
5.	Analyze and discuss the data converter architectures	L3

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	**12**

Course delivery methods	**Assessment methods**
1. Black board	1. Assignments
2. Presentation	2. Quiz
3. Videos and MOOC	3. Case studies with real time examples.
4. Practical with EDA tools.	4. Projects/ Literature survey.

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0 / 3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Electronic System Design

Course Code	18EC743	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3 – 0 – 0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course Learning Objectives (CLOs)

1. Understand the importance of SystemC in designing a system
2. Describe the modeling of systems above the Register Transfer Level of abstraction
3. Explain functional modeling and requirement of intellectual property
4. Recognize the need of communication and synchronization in systems through interfaces and channels.
5. Outline the process of refinement and the need for testing and debugging the system

Pre-requisites:

1. Computer Programming in C

Unit –I 8 Hours

Overview of System Design using SystemC and Overview of SystemC:
Introduction, Language comparison, Design methods, Enhancing productivity with SystemC. C++ mechanics for SystemC, SystemC: A C++ class for hardware, Overview of SystemC components, SystemC simulation Kernel. Data types.

Unit –II 8 Hours

Modules: A Starting point: sc_main, The basic unit of design: SC_MODULE, The SC_MODULE Class constructor: SC_CTOR, The basic unit of execution: Simulation process, Registering the basic process: SC_THREAD, Completing the simple design: main.cpp, Two styles using SystemC Macros.
Concurrency: Understanding concurrency, Simplified simulation engine, The SystemC thread process, Catching events for thread processes, Zero-time and immediate notifications, The SystemC method process, Events for method processes, Static sensitivity for processes, SystemC event queue

Unit –III 8 Hours

Channels: Primitive channels, sc_mutex,sc_semaphore, sc_fifo, SystemC signal channels, Resolved signal channels, Template specializations of sc_signal channels.
Structure: Module hierarchy, Direct top-level implementation, Indirect top-level implementation, Direct submodule header-only implementation, Direct submodule implementation, Indirect submodule header-only implementation, Indirect submodule implementation, Contrasting implementation approaches.

Unit –IV **8 Hours**

Communication: Communication: The need for ports, interfaces: C++ and SystemC, Simple SystemC port declarations, Many ways to connect, Port connection mechanics, Accessing ports from within a process.

More on Ports: Standard interfaces, Standard interfaces, Specialized ports, The SystemC port array and port policy, SystemC exports, Connectivity revisited

Unit –V **8 Hours**

Custom Channels and Data: A review of SystemC channels and interfaces, The interrupt, a custom primitive channel, The packet, a custom data type for SystemC, The heartbeat, a custom hierarchical channel, The adaptor, a custom primitive channel, The transactor, a custom hierarchical channel

Text Book

1. David C. Black, Jack Donovan,BillBunton, Anna Keist., SystemC: From the Ground Up, 2nd Edition, Springer New York Dordrecht Heidelberg London.

References

1. Grötker, T., Liao, S., Martin, G., Swan, S, "System Design with SystemC", Springer, 2002.
2. Sandro Rigo, Rodolfo Azevedo, Luiz Santos, "Electronic System Level Design,", Springer, 2011.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Recognize the need of SystemC in designing a system.	L2
2. Implement the modeling of electronic system at the register level.	L3
3. Understand a system and asses the need for intellectual property.	L2
4. Describe the communication and synchronization in electronic systems.	L2
5. Explain the concept of custom channels and data	L2

Program Outcome of the course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. Blackboard Teaching	1. Internal Assessment
2. PPT's	2. Quiz
3. Videos	3. Assignment
4. Demonstration	4. Activity

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

RF System Design

Course Code	18EC744	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To introduce the basic parameters of RF system design.
2. To appreciate the importance of the impedance matching at high frequency.
3. To explore the various RF power amplifier models.
4. To understand PLL mixers and oscillators.

Pre-requisites: Fundamentals of Electromagnetics

Unit - I **8Hours**

CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES:
Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise, Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise - Specification distribution over a communication link, Heterodyne Receiver, Image reject, Low IF Receiver Architectures, Direct up conversion Transmitter, Two step up conversion Transmitter
Case Study: Homodyne Receiver architecture.

Unit - II **8Hours**

IMPEDANCE MATCHING AND AMPLIFIERS:
S-parameters with Smith chart, Passive IC components, Impedance matching networks, Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Power match and Noise match.
Case Study: Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs.

Unit - III **8Hours**

FEEDBACK SYSTEMS AND POWER AMPLIFIERS:
Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation, General model – Class A, AB, B, C, D, E and F amplifiers, Power amplifier Linearization Techniques, Efficiency boosting techniques, ACPR metric,
Case Study: RF Power amplifier design considerations.

Unit - IV **8Hours**

PLL AND FREQUENCY SYNTHESIZERS:
Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer-N frequency synthesizers.
Case Study: Direct Digital Frequency synthesizers

Unit - V **8Hours**

MIXERS AND OSCILLATORS:

Mixer characteristics, Non-linear based mixers, Quadratic mixers, Multiplier based mixers, Single balanced and double balanced mixers, sub sampling mixers, Oscillators describing Functions, Colpitts oscillators, Resonators, Tuned Oscillators, Phase noise.

Case Study: Negative resistance oscillators.

Books

Text Book:

1. Thomas Lee, "The Design of Radio Frequency CMOS Integrated Circuits", Cambridge University Press, 2nd Edition, Cambridge, 2004.

Reference Books:

1. Matthew M.Radmanesh, "Radio frequency and Microwave Electronics illustrated", Pearson Education Inc, Delhi, 2006.
2. B.Razavi, "RF Microelectronics", Pearson Education, 1997.
3. DevendraK. Misra, "Radio Frequency and Microwave communication Circuits – Analysis and Design", John Wiley and Sons, Newyork,2004.
4. B. Razavi, "Design of Analog COMS Integrated Circuits", Mc Graw Hill, 2001.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Understand the RF receiver architectures	L2
2. Design impedance matching networks	L3
3. Analyze the stability of the RF amplifiers	L4
4. Design PLL and Oscillator circuits	L3

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2. **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**

Course delivery methods	Assessment methods
1. Blackboard Teaching	1. Internal Assessment
2. PPT's	2. Quiz
3. Videos	3. Assignment
4. Animations	4. Activity

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Deep Learning

Course Code	**18EC745**	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Examine the history of neural networks and the state-of-the-art approaches to deep learning.
2. Design neural network architectures and training procedures.
3. Analyze research articles to appreciate state-of-the-art approaches to deep learning.
4. Appreciate the use of neural networks and deep learning for solving complex problems.
5. Identify the appropriate mechanism to be applied for solving a real life problem.

Pre-requisites: Engineering Mathematics, Concepts of Neural Networks

Unit – I **8 Hours**

Introduction: Historical trends in Deep learning, Scalars , vectors matrices and tensors, Linear dependency and span, Norms, Eigen decomposition, Singular Value Decomposition, Principal component Analysis.

Probability, Random variables, probability distributions Marginal Probability, Conditional Probability, Expectation, Variance and Covariance. Common Probability distribution, Bayes rule.

Case Study: Identify a real-world problem that requires Deep learning classification and identification.

Unit – II **8 Hours**

Machine Learning Basics: Learning Algorithms, Capacity, Overfitting and Underfitting, Hyperparameters and Validation sets, Estimators, Bias and variance, Maximum likelihood estimation, Bayesian statistics, Supervised and unsupervised algorithms, Stochastic gradient descent, building a machine learning algorithm, Challenges motivating Deep learning.

Case Study: Prepare a review document on the identified real-world problem.

Unit – III **8 Hours**

Deep Networks: Modern practices Learning XOR, Gradient based Learning, Hidden Units, Architecture Design, Back propagation and other differentiation Algorithms.

Optimizations for training Deep models: Difference between Pure learning and optimization, Challenges in Neural Network optimization, Basic Algorithms, Parameter initialization strategies, Algorithms with

Case Study: Learn to use one of the tools like Deep Dream, Deep Art, GoogLeNet

Unit – IV **8 Hours**

Convolutional and Recurrent: Neural Networks and Convolution operation, Pooling, Variants of Convolutional functions, Efficient Convolution Algorithms, Random or unsupervised features, Recurrent Neural networks, Bidirectional RNN's, Encoder -Decoder, Sequence-to-

sequence architecture, Deep recurrent Networks, Recursive Neural Networks, Echo state Networks, Leaky units and other strategies for multiple time scale, Long Short-Term memory and other gated RNN's.

Case Study: Compare the effect of change in architecture on the identified problem.

Unit – V **8 Hours**

Autoencoders: Undercomplete auto encoder, regularized autoencoder, representational power, layer size and depth, Stochastic encoders and decoders, Denoising autoencoders, Learning Manifolds with autoencoders, Contractive Autoencoders, Applications of Autoencoders.

Representation Learning: Greedy Layer-wise Unsupervised Pretraining, Transfer Learning and Domain Adaptation, Distributed Representation.

Applications of Deep learning; Large scale Deep learning, Computer Vision, Speech recognition, Natural Language Processing.

Course project: Develop a deep learning application for the identified real-world problem.

Books

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press book, 2014 onwards.
2. John D. Kelleher, Deep Learning (MIT Press Essential Knowledge series)

Reference Books:

1. Hands-On Deep Learning Algorithms with Python: Master deep learning algorithms with extensive math by implementing them using TensorFlow; Paperback – Import, 25 Jul 2019
   by Sudharsan Ravichandiran
2. Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play Paperback – 25 Jul 2019
3. Deep Learning Using Python, Paperback – 2019
   by S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka
4. Deep Learning with Python Paperback – 22 Dec 2017
   by François Chollet (Author)

E-resourses (NPTEL/SWAYAM.. Any Other)- (mention course title and then url)s

1. http://www.deeplearningbook.org

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Design appropriate neural structures for simple logic problems.	L2
2.	Analyze the state of art techniques applied in deep learning research.	L3
3.	Develop deep learning models for simple classification and identification problems.	L4
4.	Analyze different deep learning models for different applications.	L4
5.	Apply knowledge of deep learning algorithms to solve real life problems.	L5

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**

3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**
5	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	**7**
7	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	**Assessment methods**
1. Classroom Teaching (Black Board)	1. IA Test
2. Presentation	2. Assignment
3. Handouts	3. Quiz
4. Video Presentations	

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Low Power VLSI

Course Code	18EC751	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Outline the fundamental effects of technology scaling on low power electronics.
2. Identify the low power techniques at circuit design level.
3. To make use of low power techniques at logic design level and low power memory design.
4. Explain fundamentals of low power microprocessor design.
5. Inspect low power methods at architecture and algorithm level.

Pre-requisites: 1.CMOS VLSI Design

Unit – I **8Hours**

Introduction, Technology and circuit design levels: Device and Technology impact on low power electronics,introduction, dynamic dissipation in CMOS, effects of UN on speed, constraints on reduction, transistor sizing and optimal Gate oxide thickness, impact of technology scaling, technology and device innovations.

Case Study:CMOS inverter design for noise margin, speed, power and timing

Unit – II **8Hours**

Low power circuit techniques: Introduction, power consumption in circuits, flip flops and latches, logic, high capacitance notes
Low power clock distribution: Power distribution in clock distribution, driver vs distributed buffers, buffer and device sizing under process variation, zero skew versus tolerable skew, chip and package co design of clock network

Case Study: Testing the low power circuits with elevated intrinsic leakage method

Unit – III **8Hours**

Logic synthesis for low power: Introduction, power estimation techniques, power minimization techniques,
Low power memory design: Introduction, sources and reductions of power dissipation in memory subsystem, sources of power dissipation in DRAM and SRAM, low power DRAM circuits, low power SRAM circuits

Case Study:Case study of combinational and sequential circuits for timing, area and power

Unit – IV **8Hours**

Low power microprocessor design: System Power management support, architectural tradeoff for power, choosing the supply voltage, low-power clocking, implementation options for low power, Power and performance, Comparing microprocessors

Case Study: Low power architecture design and compilation techniques for high-performance processors

Unit – V **8Hours**

Architectural level methodology: Introduction, design floor, algorithm level,Analysis and Optimization, architectural level, Estimation and synthesis

Case Study:Study of QAM block in communication systems

Books

Text Books:

1. Jan M. Rabaey and Massoud Pedram, "Low-power-design-Methodology", The Springer International Series in Engineering and Computer Science, 1995 and onwards.

Reference Books:

1. Kaushik Roy and Sharat C Prasad, “Low-Power CMOS VLSI Circuit Design”, John Wiley Pvt. Ltd., 2008 and onwards.
2. Gary Yeap and Kluwer, “Practical Low Power Digital VLSI Design”, Academic Publications, 1998 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom’s Level
1	**Discuss** the effects of device and technology scaling on low power electronics	L2
2	**Identify** the low power techniques at circuit level	L3
3	**Analyze** and verify memory design techniques	L4
4	**Interpret** special techniques for microprocessor design	L2
5	**Analyze** and optimize low power techniques at architecture and algorithm level	L4

	Program Outcome of this course (POs)	**PO No.**
1.	Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
2.	Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
3.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**

Course delivery methods	**Assessment methods**
1. Classroom Teaching	1. IA Test
2. Presentation	2. Assignment
3. Videos	3. Quiz
4. Notes	4. Mini project

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Multimedia Communication

Course Code	18EC752	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Understand the Concepts and Fundamentals of digital information compression.
2. Apply and analyze mathematical transform for Multimedia information.
3. Understand the design procedure of Video CoDec.
4. Analyze JPEG, JPEG 2000 still image standards.
5. Analyze and evaluate MPEG 4 and High Efficiency Video Coding (HEVC) Co-Dec standards.

Pre-requisites: Image Processing and Computer |Vision

Unit - I **8 Hours**

Fundamentals Concepts of Multimedia: Practical need for audio, image and video compression, statistical and psycho-visual redundancy, Quantization - uniform, non-uniform, Audio compression - Psychoacoustics, Audio CoDec, Lossless Compression MPEG-4, Lossy Compression G.719, AC3.

Case Study: Study and analysis of the process of quantization in compression technique.

Unit - II **8 Hours**

Coding Standard: Transform coding, DCT and DWT (for data compression), Variable length coding, Huffman codes, Arithmetic codes, Dictionary codes - LZ77 and LZ78.

Case Study: Write and verify code for transform techniques.

Unit - III **8 Hours**

Still Image and Video Compression: Still image compression coding standards, JPEG, JPEG 2000, Motion estimation and motion compensation, Block matching, fundamentals of digital video coding.

Case Study: Study and design of the JPEG compression algorithm.

Unit - IV **8 Hours**

Digital Video Coding Standard and Applications: Introduction and fundamentals H.261, H.263, MPEG 1/2 video coding, MPEG-4 video standards (Block diagram study).

Case Study: Study of MPEG-3 compression algorithm.

Unit - V **8 Hours**

HEVC High-Level Syntax: Introduction, HEVC background and development, compression capability: the fundamental need collaborative development, interoperability, and flexibility, complexity, parallelism, hardware, and economies of scale, profiles, levels, tiers, and extensibility.

Case Study: Overview of the HEVC High-Level Syntax.

Books

Text Books:

1. Yun Q. Shi and Huifang Sun, "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards, CRC Press, 2008and onwards.
2. Editors: Sze, Vivienne, Budagavi, Madhukar, Sullivan, Gary J. (Eds.)"High Efficiency Video Coding (HEVC) Algorithms and Architectures" Springer Publications.

Reference Books:

1. Ze-Nian Li and Mark S. Drew, "Fundamentals of Multimedia", Prentice Hall.
2. Fred Halsall "Multimedia Communications: Applications, Networks, Protocols And Standards" Pearson publication.

E-Resourses (NPTEL/SWAYAM.. Any Other)- mention links

1. Multimedia processing https://nptel.ac.in/courses/117/105/117105083/
2. Digital Voice & Picture Communication https://nptel.ac.in/courses/117105081/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Identify and describe multimedia signal processing and communications	L2
2. Analyze and report different transforms for video coding.	L4
3. Describe and compare Video CoDec designs.	L3
4. Describe a number of standards, including H.26x, Moving Picture Expert Group (MPEG), and Joint Photographic Expert Group (JPEG).	L4
5. Understand the concept of HEVC and its applications.	L4

Program Outcome of this course (POs)	PO No.
1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
3. **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.	**10**

Course delivery methods	Assessment methods
1. Black board	1. IA Test
2. PPT	2. Assignment
3. Videos	3. Quiz
4. Demonstrations	4. Course project/seminar

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Internet of Things (IoT)

Course Code	18EC753	**Credits**	03
Course type	PE	**CIE Marks**	50
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 Marks

Course Learning Objectives (CLOs) Redefine CLOs referring to IoE syllabus

1. To introduce the basic concepts of Internet of Things and explore the various smart objects in IoT
2. To study various communication aspects of IoT.
3. To study the WSN architecture & various security features.
4. To develop applications of IoT in various industrial environments.
5. To comprehend the security and privacy issues in IoT.

Pre-Requisites (If Any):

1. Basics of Electronics & Electrical Devices.

Unit – I 8 Hours

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Machine to Machine, Difference between IoT and M2M

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Case Studies: Identify a practical problem and develop a model for solution in IoT environment.

Unit – II 8 Hours

Network & Communication aspects:

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery

Case Study: Survey on real time challenges in sensor deployment

Unit – III **8 Hours**

Wireless Sensor Networks:

WSN Architecture, the node, connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security

Case Studies: Survey on real time challenges with respect to Security in WSN.

Unit – IV **8 Hours**

IoT Applications for Value Creations

Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry.

Mini project: Implement a possible solution modeled in unit-I using IoE concepts.

Unit –V **8 Hours**

Internet of Things Privacy, Security and Governance

Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smart Approach. Data Aggregation for the IoT in Smart Cities

Case Study: 1. Study and document Smart City Security Architecture

2. Report on Smart City Use-Case Examples.

Text Books

1. ArshdeepBahga, Vijay Madisetti, “Internet of Things A hands on approach”, Universities Press, 2015 ISBN: 978-81-7371-954-7.

2 WaltenegusDargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice”

Reference Books

1. Honbo Zhou, “The Internet of Things in the Cloud”.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand the basic principles and features of IoT and smart objects.	L2
2.	Explain network and communication aspects of IoT	L2
3.	Explain the WSN architecture & various security aspects.	L2
4.	Develop applications by applying concepts of IoT.	L3
5.	Understand security and privacy issues in IoT.	L3

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
3.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**
4.	**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.	**10**
5.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change	**12**

	Course delivery methods		**Assessment methods**
1.	Classroom Teaching (Blackboard)	1.	IA test
2.	Presentation	2.	Assignment
3.	Video presentations	3.	Quiz
		4.	Activity

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two assignments / activity	Quiz/Seminar/Course Project	Total Marks
Maximum Marks: 50	15+15=30	10	10	50

- Writing two IA tests is compulsory.
- **Minimum marks required to qualify for SEE: 20 out of 50**

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass: 40**
3. Question paper contains 10 questions each carrying 20 marks. Students have to answer FIVE full questions by selecting one full question from each unit.

Wireless Ad Hoc and Sensor Networks

Course Code	18EC754	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. To understand the basics of ad hoc wireless networks and get familiar with sensor network hardware and tools.
2. To learn ad hoc network design considerations and function of MAC protocols in such networks
3. To acquire knowledge regarding necessity, and types of general and multicast routing protocols.
4. To learn about Quality of Services (QoS) in ad hoc networks & next generation hybrid networks
5. To look at WSN from a different perspective, known as Information Processing Approach.

Pre-requisites: Signals and Systems, Communication Theory and techniques, Information Theory & Digital Communication, Microwave & Antenna Engg.
+ **Text Book 1, Chapter 1** (Introduction: Fundamentals of Wireless Communication Technology.)

Unit - I **8 Hours**

BASICS OF AD HOC WIRELESS NETWORKS AND SENSOR NETWORK PLATFORM

Ad Hoc Wireless Networks (AHWN): Cellular and Ad Hoc Networks and their differences, Ad Hoc Wireless Network (AHWN) applications, Issues in Ad Hoc Wireless Networks. (**Text 1**, Chapter 5)

Sensor Network Hardware and Tools: Berkeley MICA Mote architecture and system specifications, TinyOS, Node level simulator ns-2 & TOSSIM.
Design issues and challenges in Wireless Sensor Networks
Case Study: 1.1) How internet is made available to the end users over an Ad Hoc Wireless Network
1.2) Evolution of Discrete Event Network Simulator (ns 1, 2, 3) & its Applications

Unit - II **8 Hours**

DESIGN CONSIDERATIONS OF AD HOC NETWORKS AND MAC PROTOCOLS

Ad Hoc Sensor Networks Design Considerations: Empirical energy consumption formula, Sensing and communication range, Node localization scheme, Clustering, Network lifetime.

MAC Protocol for Ad Hoc Wireless Networks: Issues in designing MAC protocol for AHWN, Design goals and Classification of MAC protocol, Contention based MACA and

MACAW protocol, Contention based MAC with reservation mechanism – DPRMA, Multichannel CSMA MAC, Power Control MAC.

Case Study: 2.1) WSN Application – The Grand Duck Island monitoring

Unit – III **8 Hours**

ROUTING PROTOCOLS –

Routing Protocols for Ad Hoc Wireless Networks: Design issues and classification of Routing Protocols for AHWN, Table Driven – Destination Sequenced Distance-Vector Routing Protocol, Hierarchical – Fisheye State Routing Protocol, Power-Aware routing metrics.

Multicast Routing in Ad Hoc Wireless Networks: Design issues in Multicast Routing, An Architecture Reference Model for Multicast Routing Protocol, Tree Based – Bandwidth-Efficient Multicast Routing Protocol.

Case Study: 3.1) Why does TCP not perform well in Ad Hoc Wireless Networks?

3.2) Defense Advanced Research Project Agency (DARPA) efforts towards uses of WSN

Unit – IV **8 Hours**

QUALITY OF SERVICES IN AHWN AND HYBRID WIRELESS NETWORKS

Quality of Services in Ad Hoc Wireless Networks: Real-time traffic support, QoS parameters, Issues and Challenges related to QoS in AHWN, Classification of QoS solutions, Predictive Location Based QoS Routing Protocol.

Hybrid Wireless Networks: Next Generation Hybrid Wireless Architecture, MCN Architecture, HWN Architecture, SOPRANO Architecture, Power Control and Load Balancing in Hybrid Wireless Networks.

Case Study: 4.1) Energy management in Ad Hoc Wireless Networks – Battery, Transmission Power and System Power Management Schemes

Unit - V **8 Hours**

WIRELESS SENSOR NETWORKS: AN INFORMATION PROCESSING APPROACH

Sensor Tracking and Control: Task driven sensing, Roles of sensor nodes and utilities, Information based sensor tasking, Joint routing and information aggregation.

Sensor Network Databases: Sensor database challenges, Querying the physical environment, Query interfaces, High level database organization, In-network aggregation, Data-Centric storage, Data indices and range queries, Distributed hierarchical aggregation, Temporal data.

Case Study: 5.1) Lightweight signal processing and unusual applications of sensor networks

5.2) Google® for the physical world

Books

Text Books:

1. C. Siva Ram Murthy and B. S. Maonj, **Ad Hoc Wireless Networks: Architectures and Protocols**, Pearson Indian Edition, 2004 Edition, ISBN 978-81-317-0688-6.
2. Feng Zhao and Leonidas J. Guibas, **Wireless Sensor Networks: An Information Processing Approach**, Morgan Kauffmann Publishers (An Imprint of Elsevier), First Indian Reprint 2005, Indian Reprint ISBN 81-8147-642-5.
3. Carlos de Morais Cordeiro and Fharma Prakash Agarwal, **Ad Hoc and Sensor Networks, Theory and Applications**, 2nd Edition 2011, World Scientific Publication, ISBN 13 978-981-4338-88-2.

Reference Books:

1. C. K. Toh, **Ad Hoc Mobile Wireless Networks**, Pearson Education – New Delhi, 2002 onward.

2. Thomas Krag and Sebastin Buettrich, **Wireless Mesh Networking**: O'Reilly Publishers, 2007.

E-Resources - NPTEL

1. https://nptel.ac.in/courses/106/105/106105160/
   NOC: Wireless Ad Hoc and Sensor Networks, by Dr. Sudip Misra, Computer Science and Engineering, IIT Kharagpur – Video content available for 40 sessions.
2. https://nptel.ac.in/courses/117/104/117104126/
   NOC: Bayesian/ MMSE Estimation for Wireless Communications – MIMO/OFDM Cellular and Sensor Networks, by Prof. Aditya K. Jagannatham, Electronics and Communication Engineering, IIT Kanpur – Video content available for 35 sessions.

Sr. No.	List of some of the Research Papers - Title, Author, Source and Publication Details	Module
1.	Y. D. Lin, and Y. C. Hsu, "Multi-Hop Cellular: A New Architecture for Wireless Comm.," *Proceedings of IEEE INFOCOM 2000*, pp. 1273-1282, March 2000.	
2.	R. Ananthapadmanabha, B. S. Manoj, and C. Siva Ram Murthy, "Multi-Hop Cellular Networks: The Architecture and Routing Protocol," *Proceedings of IEEE PIMRC 2001*, vol. 2, pp. 78-82, October 2001.	
3.	A. N. Zadeh, B. Jabbari, R. Pickholtz, and B. Vojcic, "Self-Organizing Packet Radio Ad Hoc Networks with Overlay," *IEEE Communication Magazine*, vol. 40, no. 6, pp. 140-157, June 2002.	1, 2, 3, 4
4.	J. Hill, R. Szewcyk, A. Woo, D. Culler, S. Hollar, and K. Pister, "System Architecture Directions for Networked Sensors," *In Proc. 8th Int. Conf. on Architectural Support for Programming Languages and OS*, (ASPLOS IV), Cambridge, MA, pp. 93–104. 2000.	

Sr. No.	List of some of the Research Papers - Title, Author, Source and Publication Details	Module
5.	E. Cheong, J. Liebman, J. Liu, and F. Zhao, "TinyGALS: A Programming Model for Event-Driven Embedded Systems," *In Proc. 18th Annual ACM Symposium on Applied Computing* (SAC '03), pp. 698–704, Melbourne, FL, March 2003.	1, 2, 3, 4
6.	J. Liu and S. Singh, "ATCP: TCP for Mobile Ad Hoc Networks," *IEEE Journal on Selected Areas in Communications*, vol. 19, no. 7, pp. 1300-1315, July 2001.	1, 2, 3
7.	I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A Survey on Sensor Networks," *IEEE Commu Mag.*, vol. 40, no. 8, pp 102-114, August 2002.	1, 2
8.	Koustuv Dasgupta, Konstantinos Kalpakis, Parag Namjoshi "An Efficient Clustering—based Heuristic for Data Gathering and Aggregation in Sensor Networks," *In the Proceedings of the IEEE Wireless Communications and Networking Conf.,* (WCNC), New Orleans, Louisiana, USA, March 16-20, 2003.	2, 3
9.	W. Heinzelman, "Application-Specific Protocol Architectures for Wireless Networks," *Ph. D. Thesis*, Massachusetts Institute of Technology, June 2000.	2, 3
10.	V. Bharghavan, A. Demers, S. Shenker, and L. Zhang, "MACAW: A Media Access Protocol for WLANs," *In. Proc. ACM SIGCOMM 1994*, pp. 212-225, August 1994.	2
11.	A. Nasipuri, J. Zhuang, and S. R. Das, "A Multi-Channel CSMA MAC Protocol for Multi- Hop Wireless Networks," *In Proc. IEEE WCNC 1999*, vol. 1, pp. 1402-1406, September 1999.	2, 3, 4

12.	Z. J. Haas, "The Routing Algorithm for the Reconfigurable Wireless Networks," *In Proceedings of IEEE ICUPC 1997*, vol. 2, pp. 562-566, October 1997.	3, 4
13.	S. B. Lee, A. Gahngseop, X. Zhang, and A. T. Campbell, "INSIGNIA: An IP-Based Quality of Service Framework for Mobile Ad Hoc Networks," *Journal of Parallel and Distributed Computing*, vol. 60, no. 4, pp. 374-406, April 2000.	3, 4
14.	F. Zhao, J. Shin, and J. Reich, "Information-driven dynamic sensor collaboration," *IEEE Signal Processing Magazine*, 19 (2), pp. 61–72, 2002.	5
15.	S. Madden, M. Franklin, J. Hellerstein, and W. Hong, "TAG: A Tiny Aggregation Service for Ad-Hoc Sensor Networks," *In Proceeding, 5th Symposium on Operating Systems Design and Implementation*, (OSDI 2002), pp. 131–146, Boston, MA, ACM Press, December 2002.	5

All the above 15 Research papers can be downloaded from the link given below
https://drive.google.com/open?id=1awO3vLfSnrspsgHPEqn_M_t0dj8NI0ea

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	*Decide* about the performance measurement parameters for any Ad Hoc Network based application and wisely *choose* the network specifications to achieve them.	L3
2.	*Evaluate* the role and importance of each of the seven OSI layers toward proper functioning and *execution* of any Wireless Ad Hoc Network based applications.	L4
3.	*Analyze* performance of various MAC, Routing & Energy Management Protocols toward *optimizing* the performance of Wireless Ad Hoc & Sensor Networks.	L3
4.	*Examine* the factors to ensure QoS in general & hybrid Ad Hoc Wireless networks	L4
5.	*Appraise* the succinct introduction to the field of WSNs with a information processing based approach to *help* smarter information processing in WSNs.	L5

Sr. No.	Program Outcome of this course (POs)	PO No.
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3
4.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
5.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engg and IT tools including prediction and	5

	modelling to complex engineering activities with an understanding of the limitations.	
6.	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	6
7.	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	7
8.	**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.	10
9.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

	Course delivery methods		**Assessment methods**
1.	Self-made Slides - PPT	1.	Internal Assessment
2.	NPTEL Video Lectures - Demonstration	2.	Assignments
3.	Chalk and Talk – depending on topic	3.	Quiz
4.	Industry Expert's Lecture – on syllabus	4.	Course Seminar Presentation-group activity

CIE and SEE Pattern:

Theory courses having 3 – 0 – 0 distributions

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks

3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Data Analytics for Wearable Technology

Course Code	**18EC755**	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To explore the various forms of electronics health care information.
2. Understand conceptual and practical issues related to the collection, sharing, and structuring of healthcare data
3. To study the techniques adopted to analyze healthcare data.
4. Understand the working of wearable ECG device
5. Apply the data analytics for wearable ECG

Pre-requisites: Basic course in probability/statistics

Unit – I **8 Hours**

Introduction: Introduction to healthcare data analytics, Electronic health records, Components of EHR, Coding systems, Benefits of EHR, Barrier to adopting EHR challenges, Phenotyping algorithms.

Case Study: Survey of Electronic Health Record System Implementation in a Health Informatics

Unit – II **8 Hours**

Mining of Sensor Data in Healthcare

Introduction, Taxonomy of sensors used in medical informatics, Challenges in healthcare data analytics.

Case Study: Review of research papers on Data Mining for Wearable Sensors in Health Monitoring Systems and document.

Unit – III **8 Hours**

Data Analytics for Healthcare Clinical prediction models, Temporal data mining ,Visual analytics Clinico–Genomic data integration, Information retrieval privacy-preserving data publishing

Case Study: Study and compare any two data analytic methods implemented in healthcare. (Brenda and IBM Watson)

Unit – IV **8 Hours**

Wearable ECG: Basics of ECG, Artifacts in ECG, Ambulatory monitoring, Challenges in ambulatory monitoring.

Case Study: Study of wearable ECG monitoring device.(HeartBit by IBM)

Unit – V **8 Hours**

Analytics of ECG Data: QRS detection methods, Declination of wave boundaries, Beat alignment, Noise reduction in ECG, Overview of wearable ECG recorders, Analysis of ambulation in ECG

Case Study: IBM Watson Analytics Cloud Platform as Analytics-as-a-Service System for Heart Failure Early Detection

Books

Text Books:

1. Chandan K. Reddy, Charu C. Aggarwal, "Healthcare Data Analytics", CRC Press Taylor & Francis Group, 2015 & onwards
2. Subhasis Chaudhari, Tanmay D. Pawar, Siddhartha Duttagupta, "Ambulation Analysis in Wearable ECG", springer science+Buisness Media, LLC 2009 & onwards
3. Joseph L. Dvorak, "Moving Wearable into the Mainstream Taming the Borg". Boston, MA: Springer Science + Business Media, LLC., 2008

Reference Books:

1. Barbara Pernici, Stefano Della Torre, Bianca M. Colosimo, TizianoFaravelli Roberto Paolucci, "Wearing Embodied Emotions A Practice Based Design Research on Wearable Technology", SPRINGERBRIEFS IN APPLIED SCIENCES AND TECHNOLOGY ,2013
2. Thomas A Runkler, "Data Analytics Models and Algorithm for intelligent Data Analysis", Springer Vieweg, 2012

E-resourses(NPTEL/SWAYAM.. Any Other)- mention links

1. Proceedings 4th International Workshop on Wearable and Implantable body sensor network (BSN 2007) RWTH Aachen University, Germany. URL: https://books.google.co.in/books?id=zxaO1RBfhfQC&pg=PA8&lpg=PA8&dq=4th+International+Workshop+on+Wearable+and+Implantable+body+sensor+network+(BSN+2007)+RWTH+Aachen+University,+Germany.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand the working of healthcare electronic data recorders.	L2
2.	Apply the data mining techniques for healthcare data.	L3
3.	Analyze the healthcare data using appropriate analytic techniques.	L4
4.	Study the Wearable device technology applied to healthcare.	L2
5.	Analyze the Wearable ECG device data using different data analytic techniques.	L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**

3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**
5	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	**7**
6	**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.	**10**
7	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	**12**

	Course delivery methods		**Assessment methods**
1.	**Classroom Teaching (Black Board)**	1.	**IA Test**
2.	**Presentation**	2.	**Assignment**
3.	**Handouts**	3.	**Quiz**
4.	**Video Presentations**		

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks

3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Sensors and Signal Conditioning

Course Code	**18EC761**	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To introduce various types of sensors, classification and sensor-based measurement system.
2. To study resistive sensors and signal conditioning for resistive sensors.
3. To study reactance, variation and electromagnetic sensors and their signal conditioning.
4. To study signal conditioning for self-generating sensors.
5. To study digital and intelligent sensors and their signal conditioning methods.

Pre-requisites: Basic Engineering Mathematics and Basic Electrical and Electronic Engineering.

Unit – I: Introduction to Sensor-Based Measurement Systems 8 Hours

General Concepts and Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials for Sensors, Micro sensor Technology and Problems as applicable

Case Study: Sensors used in local industries such as foundries, energy micro system and milk factories

Unit – II: Resistive Sensors & Self-Generating Sensors 8 Hours

Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas Sensors, Liquid Conductivity Sensors and Problems as applicable, Thermoelectric Sensors, Thermocouples, Piezoelectric Sensors, Pyro electric Sensors, Photovoltaic Sensors, Electrochemical Sensors and Problems as applicable

Case Study: Industrial applications of LDRs, RTDs, Pyro Electric Sensors, Photovoltaic and Electrochemical Sensors.

Unit – III: Signal Conditioning for Resistive Sensors 8 Hours

Measurement of Resistance, Voltage Dividers, Wheatstone Bridge: Balance Measurements, Wheatstone Bridge: Deflection Measurements, Differential and Instrumentation Amplifiers, Interference and Problems as applicable

Case Study: Use of resistive sensors in industries.

Unit – IV: Signal Conditioning for Self-Generating Sensors 8 Hours

Chopper and Low-Drift Amplifiers, Electrometer and Trans impedance Amplifiers, Charge Amplifiers, Noise in Amplifiers, Noise and Drift in Resistorsand Problems as applicable
Case Study: Biomedical Sensors and related signal conditioners.

Unit – V: Digital, Intelligent Sensors and Applications **8 Hours**

Position Encoders, Resonant Sensors, Variable Oscillators, Conversion to Frequency, Period, or Time Duration, Direct Sensor-Microcontroller Interfacing, Communication Systems for Sensors, Intelligent Sensors and Problems as applicable
Case Study: Sensors used in Instrument Landing system at Airport.

Books

Text Books:

1. Ramon Pallaas-Areny, John G. Webster "SENSORS AND SIGNAL CONDITIONING", 2nd Edition, Wiley- Interscience Publication

Reference Books:

1. Sawhney A.K. and Sawhney P., A Course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai (2008)
2. Murthy D.V.S. Transducers and Instrumentation, Prentice Hall of India (2003)

E-resources (NPTEL/SWAYAM.. Any Other)- mention links

1. A brief introduction of Micro-Sensors by IISER Bhopal
2. Optical Sensors https://nptel.ac.in/courses/115/107/115107122

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Select the appropriate sensor for given application	2
2. Design a suitable signal conditioning circuit for given application	4
3. Design data acquisition system for instrumentation application	4
4. Develop suitable interface for reading sensor data	3
5. Analyze, formulate and select suitable sensor for the given industrial applications	3

	Program Outcome of this course (POs)	PO No.
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**
5.	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	**6**

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

Course delivery methods	Assessment methods
1. Blackboard teaching	1. Internal Assessment
2. PowerPoint presentation.	2. Quiz
3. Scilab/Matlab tools.	3. Seminar
4. Industrial visit	4. Activity

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Multimedia Processing

Course Code	18EC762	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To provide a broad treatment of the fundamentals of speech, image, audio and video processing
2. To familiarize the student with the speech processing techniques.
3. To introduce the student with range of image processing techniques.
4. To appreciate the use of audio processing techniques.
5. To expose the students to real-world applications of video processing.

Pre-requisites: Digital Signal Processing

Unit - I **8 Hours**

INTRODUCTION TO MULTIMEDIA: Definition of Multimedia, Multimedia objects: Text, Graphics, Animation, Audio, images, Video. Definition of Hypertext and Hypermedia. Multimedia Applications in Education, Entertainment. Advertising world etc. Components of a Multimedia System, Desirable Features for a Multimedia System, requirements of Multimedia Communication.

Case Study: Understanding of basic signal processing related to multimedia.

Unit - II **8 Hours**

SPEECH PROCESSING: Physiology of speech generation- characteristic of speech sounds, glottal excitation; speech, production models: discrete-time speech production model; discrete-time filter model for speech production, source excitation model.

Linear prediction analysis- All-pole models, least-squares estimation, spectral matching, spectral envelopes; applications of LP analysis.

Speech coding- Coder's attributes; waveform coding, vocoders.

Case Study: Analysis of speech signal by using standard computing tools.

Unit - III **8 Hours**

IMAGE PROCESSING: Fundamentals of digital image: Digital image representation and visual perception, image sampling and quantization. Image enhancement - Histogram processing, Median filtering, Low-pass filtering, High-pass filtering, Spatial filtering, Linear interpolation, zooming.

Image analysis and segmentation- Feature extraction, Histogram, Edge detection, Thresholding. Image representation and description -Boundary descriptor, Chaincode, Fourier descriptor, Skeletonizing, Texture descriptor, Moments.

Case Study: Enhancement techniques of image signal by using standard computing tools.

Unit - IV **8 Hours**

AUDIO PROCESSING: Fundamentals of digital audio, Sampling, Dithering, Quantization, psychoacoustic model.

Basic digital audio processing techniques: Anti-aliasing filtering, Oversampling, Analog-to-digital conversion, Dithering; Noise shaping; Digital-to-analog Conversion, Equalization.

Digital Audio compression: Critical bands, threshold of hearing, Amplitude masking, Temporal masking, Waveform coding, Perceptual coding; Coding techniques, Sub band coding and Transform coding; Codec examples.

Case Study: Analysis of psychoacoustic behavior of audio signals.

Unit – V **8 Hours**

VIDEO PROCESSING: Fundamentals of digital video: Basics of digital video, digital video formats.

Basic digital video processing techniques: Motion estimation, Inter-frame filtering, Motion compensated filtering, Error concealment.

Video coding techniques: Temporal redundancy, Spatial redundancy, Block-based motion estimation and compensation; Coding techniques, Model-based coding, Motion-compensated waveform coding, Codec examples.

Case Study: Motion estimation and analysis of video signal, related applications.

Books

Text Books:

1. R.C. Gonzalez and R.E. Woods, Digital image processing, 2nd ed., Prentice-Hall, 2002.
2. J.R. Deller, J.G. Proakis, and J.H.L. Hansen, Discrete-Time Processing of Speech Signal, MacMillan Pub. Company, 2000.

Reference Books:

1. Yao Wang, Joern Ostermann, and Ya-Qin Zhang, Video Processing and Communications, Prentice-Hall, 2002.
2. Ken C. Pohlmann, Principles of digital audio, 3rd ed., McGraw-Hill, 1995.
3. L.R. Rabiner and B.H. Juang, Fundamentals of Speech Recognition, Prentice-Hall, 1993.
4. T.P. Barnwell III, K. Nayebi, and C.H. Richardson, Speech Coding: A Laboratory Textbook, John Wiley & Sons, Inc., 1996.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand the fundamentals of speech, image, audio and video signal processing and associated techniques.	L2
2.	Solve practical problems with some basic speech, image, audio and video signal processing techniques.	L3
3.	Design simple systems for realizing some multimedia applications with some basic speech, image, audio and video signal processing techniques.	L4

Program Outcome of this course (POs)		**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**

2.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
3.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	**4**
4	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	**12**

Course delivery methods	**Assessment methods**
1. Classroom Teaching (Blackboard)	1. IA test
2. Presentation	2. Assignment
3. Videos	3. Quiz
4. Notes	4. Mini Project

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

System Modeling

Course Code	18EC763	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives (CLOs)

1. Understand fundamental need of modeling of physical systems and demonstrate the basic steps related to modeling of systems from interdisciplinary fields.
2. Develop system model for linear physical systems and find interrelationship between the combinational system models.
3. Determine non-linear system models from the fields like mechanics, hydraulics, economics, and finance with model linearization techniques.
4. Develop models for better understanding of biological, societal and crucial decision-making processes and estimate their performance.
5. Define the controller design techniques for model-based control and related applications.

Pre-requisites:

1. Engineering Mathematics

Unit - I 8 Hours

Basics of System Modeling: Necessity and basic principles of system modeling, 'Wisdom Hierarchy' of system model in this age of data, REDCAPE – the seven uses of system models, dimension analysis of systems, 'One to Many' approach of models, bagging or bootstrap aggregation of models, approximation validation and error analysis of system models, system model from given data, exponential growth and decay.

Unit – II 8 Hours

Modeling of Linear Physical Systems: Basic modeling concepts for linear systems, translational and rotational mechanical system models, electrical equivalence to mechanical system models, models of basic hydraulic, pneumatic & thermal systems, combinational linear system models – electromechanical (rack and pinion arrangement), hydro-mechanical systems, multivariable linear system models.

Unit – III **8 Hours**

Non-linear, Economic and Financial System Models: Introduction to non-linear functions and non-linear system models, linearization of non-linear system models.

(Economic Systems): Market forces of supply-demand and government policies, economic growth model of a country, feedback control system model for measurement and control of national income.

Case Study: The Model for Making Money – 'Making money with algebra', buying a car now or later, financial planning for retirement.

Unit - IV **8 Hours**

Biological, Societal and Decision Models: Modeling of diabetes in human beings, dynamic model for information processing in human brain, SEIR – model for understanding the spread of infectious disease like Covid19, model for growth of cancerous cells in human body and its control by chemotherapy, computational model of arterial blood flow for treatment of vascular diseases.

Case Study: Lotka-Volterra prey-predator model for society, resource management at fisheries, population dynamics within a country, Markov's decision making model.

Unit - V **8 Hours**

Controller Design for Modeled Systems: Controller parameters, single loop and multi loop controllers, on-off controller, proportional controller, PID controller, tuning of PID controller, model based design of controllers.

Case Study: Kalman filter based design.

Text Books

1. Clive L. Dym, "Foundations and Applications of Mathematical Modeling," Elsevier Academic Press, 2nd edition, 2004, ISBN: 978-0-122-26551-8 (e-book).
2. Scott E. Page, "The Model Thinker – What You Need to Know to Make Data Work for You," Basic Books, Hachette Group Inc., NY, 1st edition, 2018, ISBN: 978-0-465-09463-9 (e-book).
3. W. Bolton, "Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering," Pearson Education Limited, 3rd edition, 2003, ISBN:0-131-21633-3.
4. N. Gregory Mankiw, "Principles of Economics," CENGAGE Learning, 8th edition, 2018, ISBN: 978-1-305-58512-6 (e-book).

5. Su Whan Sung, Jietae Lee, and In-Beum Lee, "Process Identification and PID Control," John Wiley and Sons (Asia) Pte Ltd., IEEE Press, 1st edition, 2009, ISBN 978-0-470-82410-8.

6. Mohinder S. Grewal, and Angus P. Andrews, "KALMAN Filtering – Theory and Practice using MATLAB®," Wiley Publication, 4th edition, 2015, ISBN 978-1-118-85121-0.

E-resources

1. MATLAB based Control System - Pdfs – 10 module notes - Electrical Engineering IIT Delhi

   Web Link - https://nptel.ac.in/courses/108102044/

2. Prof. S. D. Agashe - Control Systems Video Lecture Series - Electrical Engineering IIT Bombay

   Web Link - https://nptel.ac.in/courses/108101037/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
CO-1	*Illustrate* the necessity and basic principles of system modeling and also validat*e* whether the model is proper or not through model error *analysis*.	L3
CO-2	*Develop* system transfer function for basic linear physical systems & *determine* the *relationships* between combined system models from multiple domains.	L4
CO-3	*Apply* the basic concepts to model non-linear systems from the fields of economics, finance and *appraise* the model linearization technique used to facilitate system analysis using standard tools and software.	L4
CO-4	*Model* biological, and societal events of both linear and non-linear types and also *examine* Markov's model for more judicious decision making.	L5
CO-5	*Utilize* the standard controller algorithms for model based system control and also *examine* the effectivity of Kalman Filtering for system model analysis.	L3

Sr. No.	**Program Outcome of this course (POs)**	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	3

4.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	4
5.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6.	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	6
8.	**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.	10
9.	**Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.	12

Course delivery methods	Assessment methods
1. Classroom teaching (Chalk-Board)	1. IA Tests – individual activity
2. Power Point presentations	2. OBAs – individual activity
3. Relevant video clip show in classroom	3. Quiz – individual activity
4. MATLAB based live project demo in classroom	4. Course Seminar – group activity

CIE and SEE pattern:

Theory courses having 3 – 0 – 0 distributions

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50

Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Digital Forensics

Course Code	**18EC764**	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. To understand the key aspects of Digital Forensics.
2. To study the nature of a typical digital forensics case, the correct procedures for searching and seizing evidence and evaluation of a case.
3. To study the E-mail and Social Media Investigations related to Digital Forensics.
4. To comprehend the Mobile Device Forensics and Cloud Forensics.

Pre-requisites: Basics of electronic systems

Unit - I **8 Hours**

Understanding the digital forensics profession and investigations: an overview of digital forensics, preparing for digital investigations, maintaining professional conduct, preparing a digital forensics investigation, procedures for private-sector high-tech investigations, understanding data recovery workstations and software, conducting an investigation

Data acquisition: understanding storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, using acquisition tools
Case Study: Study of Redundant Array of Independent Disks (RAID) Data Acquisition from a computer.

Unit - II **8 Hours**

Processing crime and incident scenes: identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case.
Case Study: Study of SHA-1, MD5

Unit - III **8 Hours**

Working with windows and Command Line Interface systems: understanding file systems, exploring Microsoft file structures, examining NTFS disks, understanding whole disk encryption, understanding the windows registry, understanding virtual machines
Digital forensics analysis: determining what data to collect and analyze, addressing data-hiding techniques
case study: Understanding bootstrap loader sequence in a computer.

Unit - IV **8 Hours**

E-mail and social media investigations: exploring the role of e-mail in investigations, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations,

understanding e-mail servers, using specialized e-mail forensics tools, applying digital forensics to social media.

Case Study:

1. Study of "Elephant in the Room: Case Studies of Social Media in Civil and Criminal Cases," Mark Lanterman, http://blog.x1discovery.com/2014/06/10/elephantin-the-room-case-studies-of-social-media-in-civil-and-criminal-cases/, June 2014.
2. Demonstrate the use of Forensic Toolkit (for Facebook by Afentis Software) to discover friends and other information of a public profile.

Unit - V **8 Hours**

Mobile device forensics: understanding mobile device forensics, understanding acquisition procedures for mobile devices

Cloud forensics: an overview of cloud computing, legal challenges in cloud forensics, technical challenges in cloud forensics, acquisitions in the cloud, conducting a cloud investigation, tools for cloud forensics

Case Study: Study of SIM Manager tool to read the sim card messages.

Books

Text Books:

1. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations: Processing Digital Evidence", Fifth Edition, Cengage Learning, 2015 and onwards.
2. Cory Altheide, Harlan Carvey, "Digital Forensics with Open Source Tools", Elsevier, Syngress publications, 2011 and onwards.

Reference Books:

1. John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Second Edition, ISBN 1-58450-389-0, 2005 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Understand the basic concepts of digital forensics and study the forensic tools	L2
2.	Analyze the forensic data acquired from an electronic system	L4
3.	Analyze the e-mail and social media digital forensics and document	L5
4.	Understand the digital forensics applied to mobile and cloud scenario	L3

	Program Outcome of this course (Pos)	PO No.
1.		**PO 1**
2.	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	**PO 3**
3.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	**PO 4**
4.	**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.	**PO 5**

5.	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	**PO 6**
6.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO 8**

Course delivery methods	**Assessment methods**
1. Classroom Teaching (Blackboard)	1. IA test
2. Presentation	2. Assignment
3. Video presentations	3. Quiz
	4. Activity

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0 / 3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Biomedical System Design

Course Code	18EC765	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L – T – P	3 – 0 – 0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives (CLOs)

1. Introduce students to Biomedical Engineering and its related areas.
2. Explain and apply basic concepts of semiconductor physics relevant to building circuit and device models.
3. Explain, describe, and use physics-based device and circuit models for biomedical applications.
4. Learn the process of modelling a Human Physiological System.
5. Select models appropriate to a specific need and apply those models to analyze the models.

Pre-requisites: Engineering Mathematics, Devices, Circuits, Signals and Embedded Systems

Unit - I 8 Hours

Introduction to System Science: Notion of dynamic systems: modeling and simulation using

Simulation tool - Biomedical systems as dynamic systems - Compartmental modeling of biological systems - Eye movement model – Muscle model - Classical system identification. Moral and ethical issues in developing Biomedical Systems Morality and ethics - Two moral norms: beneficence and nonmaleficence - Human experimentation - Regulation of medical device innovation – Ethical issues in feasibility studies - Ethical issues in treatment use.

Case Study: Baroreceptor Modeling: An Interactive Cardiovascular Simulation.

Unit - II 8 Hours

Anatomy and Physiology: Introduction-Cellular organization – Tissues - Major organs and systems – Homeostasis Biomedical sensing Bioelectric phenomena - Origin of bio-potentials - Notion of Hodgkin-Huxley and Soliton models - Biopotential measurements – ECG, EEG, EMG, ERG, ENG.

Case Study: Revisiting the mechanics of the action potential (Nature Communications).

https://blogs.princeton.edu/research/2015/04/01/revisiting-the-mechanics-of-the-action-potential-nature-communications/

Unit - III **8 Hours**

Biomedical Sensors: Chemical biosensors – Electrochemical sensors and chemical fibro-sensors - Notion of ion selective field effect transistor (ISFET) and immunologically sensitive field effect transistor (IMFET) - Fundamentals of light propagation in biological tissue – Biophysical measurement techniques using light – photoplethysmography – Acoustic biosensors – phonocardiography – Photoacoustic bio-signals – estimation of blood glucose.

Case Study: A fetal biophysical profile.

https://www.mayoclinic.org/tests-procedures/biophysical-profile/about/pac-20393061

Unit - IV **8 Hours**

Bio-signal processing: Characterization of bio-signals – morphological, statistical and transform features - Frequency domain representation of bio-signals – Noise characteristics - Noise reduction by Ensemble Averaging and Linear Time Invariant A Posteriori - filtering techniques - Signal averaging –

Wavelet transform - Compression of bio-signals - lossless and lossy compression.

Case Study: Neuro-Fuzzy Model for Arrhythmia Diagnostic System.

https://pdfs.semanticscholar.org/591f/26b4940a59afa5762ea23a760f02ad152dbf.pdf

Unit - V **8 Hours**

Biomedical embedded systems: Choice of embedded core - Notion of Internet of Things as extended to biomedicine – Embedded processing for disease diagnosis – Wearable biomedical embedded systems - Point of care testing devices – Diagnostic processing for detection and classification of diseases –

Computational intelligence techniques for disease diagnosis - Classification of cardiac, neuromuscular, neurological and haematological diseases - Memory management issues for diagnostic processing - Power reduction techniques in diagnostic systems.

Case Study: Ultralow-Power Electronics for Biomedical Applications.

https://www.semanticscholar.org/paper/Ultralow-power-electronics-for-biomedical-Chandrakasan-Verma/453f0b69deb71fbc6bd2850c54acd3c9f2527009

Books

Text Books:

1. 1. J. Enderle, S. Blanchard, J. Bronzino, "Introduction to Biomedical Engineering", Elsevier Academic Press, 2009.
2. R. Begg, D.T.H. Lai, M. Palaniswami, "Computational Intelligence in Biomedical Engineering", CRC Press, 2008.

Reference Books:

1. L. Sornmo, P. Laguna, "Bioelectrical Signal Processing in Cardiac and Neurological Applications", Elsevier Academic Press, 2005.
2. J.G. Webster, "Medical Instrumentation: Application and Design", John Wileyand Sons, 2003.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Describe what biomedical engineers do in their professional activities	L2
2.	Familiarize themselves with the basic components that constitute biological systems (at organs and systems level)	L2
3.	Understand and apply generalizable engineering concepts to describe many types of systems found in biology and medicine. Systems include physiological systems (organs and systems level), bioelectronics systems, sensing and transducing systems, computational systems, etc.	L3
4.	Apply standard device models to explain/calculate critical internal parameters and standard characteristics of the device	L3
5.	Analyze physiological systems and design engineering systems to measure various pathophysiological parameters	L4

	Program Outcome of this course (POs)	PO No.
1.	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2.	Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2
3.	Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and	5

modelling to complex engineering activities with an understanding of the limitations.

Course delivery methods	Assessment methods
1. Classroom Teaching (Blackboard)	1. Internal Assessment Test
2. Presentation	2. Assignment
3. Video presentations	3. Course Seminar/Project
4.	4. Case Study

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0 distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Electric and Hybrid Vehicles

Course Code	18EC766	**Credits**	03
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3 – 0 – 0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hrs.

Course learning objectives

Course learning objectives (CLOs)

1. **Understand** environmental impact and vehicle fundamentals due to electric and fuel powered vehicles
2. **Study** different propulsion systems in electric and hybrid vehicles
3. **Realize** various energy storage devices and know the regeneration of energy
4. **Learn** the architecture of electric and hybrid vehicles
5. **Appreciate** various aspects of series and parallel hybrid designs

Pre-requisites: Basic principles of energy conversion

Unit - I **8 Hours**

Environmental Impact and Vehicle Fundamentals

Petroleum resources, induced cost, air pollution, global warming, importance of different transportation development, history of electric and hybrid electric vehicles, history of fuel cell vehicles, general description of vehicle movement, concept of vehicle resistance, power train, tractive effort and vehicle speed, vehicle performance, operating fuel economy

Self-learning topics: Latest update on environmental impact of IC engines

Unit - II **8 Hours**

Propulsion Systems

Spark ignited IC engines, Compression ignition IC engines, gas turbine engines- Operating principle

Electrical Drives: Configuration of electric vehicles, DC Motor Drives- Principle of operation and performance, combined armature and voltage control, chopper control of DC motor drives, Induction motor drive- Basic operating principle, various control methods, BLDC motor drive- Basic principle, Control of BLDC drive, SRM drive- basic principle and control

Self-learning topics: Principle of DC motor

Unit - III **8 Hours**

Energy Storage and Regeneration

Electrochemical batteries and its types- Electrochemical reaction, thermodynamic voltage, specific energy, power, efficiency, different battery technologies in EV and HEV, Battery Management System

Ultra-capacitors- Features, Basic operating principle, Performance, ultra-capacitor technologies

Ultra-high-speed flywheels- operating principle, power capacity, different flywheel technologies

Fundamentals of regenerative braking- Energy consumption in braking, braking power and energy on front and rear wheels, brake system for EV and HEV

Case studies

Self-learning topics: Ultra-high-speed flywheels

Unit - IV **8 Hours**

Electric Vehicles (EV)

Configurations of EV, Performance of EV, Traction motor characteristics, tractive effort and transmission requirement, vehicle performance, tractive effort in normal driving, energy consumption

Hybrid Electric Vehicles (HEV)

Concept of hybrid electric drive trains, architecture of HEV drive trains, series hybrid, parallel hybrid electric drive trains.

Unit - V **8 Hours**

Hybrid Drive Train Designs

Series Hybrid Electric Drive Train Design- Operation patters, control strategies, PPS control, Thermostat control, Sizing of major components, power rating design of traction motor and engine, Design of Peaking Power Source (PPS)

Parallel Hybrid Drive train design –Control strategies, State of charge (SOC) control, engine on-off control, Design of engine, motor and PPS, case studies

Text Books

1. Modern Electric, Hybrid Electric and fuel cell vehicles, MehrdadEhsani, Yimin Gao, CRC Press, 2005
2. Electric and Hybrid Vehicles, Iqbal Husain, CRC Press, 2010
3. Electric Vehicle Technology Explained, James Larminie, John Lowry, John Wiley,2003

Reference Books

1. Fundamentals of Electrical Drives, G. K. Dubey, CRC Press,2002
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Chris Mi, M. AbulMasrur and David Wenzhong Gao, Willey Publications, 2011

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** vehicle mechanics & impact on environment of traditional transportation system.	L2
2.	**Describe** suitable energy storage & regeneration system for Electric and Hybrid Electric Vehicles	L3
3.	**Classify** different types of Electric and Hybrid Electric Vehicles	L2
4	**Choose** appropriate propulsion technique for Electric and Hybrid Electric Vehicles	L3
5	**Select** suitable drive train and control mechanism for Electric and Hybrid Electric Vehicles	L3

Program Outcome of this course (POs)

		PO No.
1.	Engineering knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	1
2.	Problem analysis: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	2

3.	The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issuesand the consequent responsibilities relevant to professional engineering practice.	6
4.	Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	7

Course delivery methods

1. Lectures
2. PPT
3. Lab demo

Assessment methods

1. Internal Assessment tests
2. Assignments
3. Quiz
4. Course seminar

CIE and SEE Pattern:

Theory courses having 4 – 0 – 0/3 – 0 – 0distribution:

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE: 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Microwave and Antenna Lab

Course Code	18ECL77	**Credits**	1.5
Course type	L1	**CIE Marks**	25 marks
Hours/week: L – T – P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. To have detailed study on microwave equipments and microstrip components.
2. To understand the concepts and principles of microwave engineering.
3. To gain knowledge on operation of different microwave devices.
4. To explore characteristics of an antenna.

List of experiments

Part A (Hardware)

1. (a) Study of microwave instruments,
   (b) Study of waveguide and microstrip components,
   (c) Study of reflex klystron characteristics.
2. Characteristics of Gunn Oscillator and Gun diode as modulated source.
3. (a) Isolation and coupling coefficient of E, H and Magic Tee.
   (b) Measure Coupling coefficient, Insertion loss and Directivity of a Directional Coupler.
4. (a) Characteristics of a Microstrip Power Divider (PD): Power Division and Isolation.
   (b) Measurement of the standing wave ratio and reflection coefficient in a microwave transmission line (waveguide).
5. Measurement of resonance characteristics of a microstrip ring resonator and determination of dielectric constant of the substrate.
6. To measure the frequency of a microwave source and demonstrate relationship among guide dimensions, free space wavelength and guide wavelength.
7. Measurement of directivity and gain of standard dipole microstrip patch antenna and Yagi antenna (printed).

Part B (Software)

1. MATLAB program to plot two-dimensional (2-D) polar and semi polar patterns of $\cos^2\theta$, $\sin^2\theta$, $\cos^2\theta + \cos\theta$ and $\sin^2\theta + \sin\theta$.
2. MATLAB program to calculate the:
   (a) Radiated power,
   (b) Maximum directivity (dimensionless and in dBi) of any antenna.
3. MATLAB program to computes the:
   (a) Maximum directivity (dimensionless and in dB),
   (b) Radiation resistance (Rr),
   (c) Normalized current distribution,
   (d) Directivity pattern (in dB) in polar form,
   (e) Normalized far-field amplitude pattern (E-theta, in dB) in polar form for a symmetrical dipole of finite length.
4. MATLAB program to computes the:
   (a) Maximum directivity (dimensionless and in dB),
   (b) Radiation resistance (Rr),
   (c) Normalized current distribution,
   (d) Directivity pattern (in dB) in polar form,

(e) Normalized far-field amplitude pattern for a circular loop (with constant current).

5. MATLAB program that computes the radiation characteristics of:
   (a) Linear Arrays (Uniform & Broadside Non-uniform).
   (b) Planar Array (Broadside Uniform).
6. Simulation of a 2.4 GHz Patch Antenna using IE3D/Antenna Magus.

Books

1. Annapurna Das and Sisir K Das, "Microwave Engineering", TMH Publication, 2nd Edition, 2010 and onwards.
2. Liao, "Microwave Devices and circuits", Pearson Education.
3. John D. Krauss, "Antennas and Wave Propagation", 4th Edition, McGraw-Hill International, 2010 and onwards.

Reference Books:

1. David M. Pozar, "Microwave Engineering", John Wiley India Pvt. Ltd., 3rd Edition, 2008 and onwards.
2. C. A. Balanis, "Antenna Theory Analysis and Design", 3rd Edition, John Wiley India Pvt. Ltd., 2008 and onwards.
1. C. A. Balanis, "Antenna Theory Analysis and Design", 3rd Edition, John Wiley India Pvt. Ltd., 2008 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. Understand basic principles involved in microwave engineering.	L2
2. Analyze the performance of waveguides and resonators.	L5
3. Apply computational tools to study the performance of various antennas.	L3
4. Evaluate antenna performance parameters using simulation tool.	L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**

Assessment methods

1. Internal Test
2. Quiz
3. Activity

Lab courses:

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE: 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Wireless and Mobile Communication Laboratory

Course Code	**18ECL78**	**Credits**	1.5
Course type	L2	**CIE Marks**	25 marks
Hours/week: L – T – P	0 – 0 – 3	**SEE Marks**	25 marks
Total Hours:	36 Hrs	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. To enable the student to work on GSM technology with GSM kit.
2. To enable the student to demonstrate wireless modulation techniques.
3. To enable the student to work with emerging wireless technologies like Bluetooth, Zigbee, RFID.

Pre-requisites: Information Theory and Digital Communication (18EC53)

List of experiments

1. GSM kit experiments – call making, call receiving, SMS sending, receiving, listing, deleting, signal measurement.

MATLAB based experiments:

2. BPSK
3. DPSK
4. QPSK
5. QAM
6. MIMO
7. OFDM

Kit based experiments:

8. Bluetooth
9. RFID
10. Zigbee

Books

1. Gary J. Mullet, Introduction to wireless telecommunications systems and networks, Cengage learning, 2006.
2. Theodore S. Rappaport, Wireless Communications- Principles and Practice, Pearson, 2nd Ed, 2010.
3. **Reference Books:**
4. Jochen Schiller, Mobile Communications, Pearson Education, 2nd Ed, 2004.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Demonstrate wireless communication operations**	L3

2.	**Simulate wireless modulation techniques**	L3
3.	**Work with emerging technologies**	L4

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	**1**
2.	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	**2**
3.	**Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	**3**
4.	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**5**
5.	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	**7**

Assessment methods

1. **Test**
2. **Quiz**
3. **Viva**

Lab courses:

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE: 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks

	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Course Code: 18EC81	Internship	Total credits	2
Course type: PC(INT)	CIE Marks: 50 marks	SEE Marks	NIL

At the End of the sixth / Seventh semester Research/Industrial Internship shall be carried. All the students admitted shall have to undergo a mandatory internship of 6-8 weeks during the vacation of 6^{th} / 7^{th} semesters. A Viva-Voce examination shall be conducted during 7^{th} /8^{th} semester and the prescribed credit shall be included in 8^{th} semester. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent semesters.

Course Outcome (COs)

At the end of the course, the student will be able to		Learning Level	PO(s)
1.	articulate and apply principles learned in the classroom to a specific internship site experience.	L3	PO1
2.	develop work competencies for a specific profession or occupation.	L3	PO2
3.	present thoughts and ideas clearly and effectively in written and oral forms as required for particular workplace settings.	L3	PO10
4.	gain self-understanding, self-confidence, develop interpersonal skills, develop effective work habits, including time management, punctuality, and personal accountability.	L3	PO10
5.	explore career options and gain general work experience.	L5	PO12

Scheme of Continuous Internal Evaluation (CIE):

- Internship shall be evaluated for 50 marks as Continuous Internal Evaluation and no SEE.
- Continuous Internal Evaluation for a total of 50 marks will be awarded by internal guide, external guide, and the department committee.
- The department shall schedule for the presentation which will be evaluated by a team of faculty members.
- The evaluation could be done at the beginning of 7^{th} /8^{th} semester and marks for the grades could be submitted in 8^{th} sem.
- The student shall submit FOUR COPIES of the final report for SEE. After completion of the viva-voce, signed copy of the report shall be submitted to student, internal guide, external guide and the department library.

Internal guide marks	External guide marks	Presentation marks	Final Marks
15	25	10	50

Course Code: 18EC82	Intellectual Property Rights (IPR)	Total credits	1
Course type: HS	CIE Marks: 50 marks	SEE Marks	NIL

Students have to undergo 6-8 weeks of IPR certification course NPTEL/SWAYAM/WIPO/VTU. They can take this certification course anytime from 3rd - 8th semester. The prescribed credit shall be included in 8th semester. The certification shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the certification shall be declared fail and shall have to complete during subsequent semesters.

Course Outcome (COs)

At the end of the course, the student will be able to		Learning Level	PO(s)
1.	get an adequate knowledge on patent, copyrights, etc., and related documents, and professional ethics	L2	PO8
2.	Apply procedural knowledge related to patent.	L3	PO8

- IPR Certification course shall be evaluated for 50 marks as Internal Evaluation and no SEE.
- Internal Evaluation for a total of 50 marks will be awarded by the department committee. The scores are based on the performance evaluation done by the organisation offering the certification course.
- Student shall submit the copy of the assessment report and the certificate to the mentor/guide.

Course Code:18EC83	Professional Certification -1 (Language Certification)	Total credits	1
Course type: HS	CIE Marks : 25 marks	SEE Marks	NIL

Students have to undergo English/any other foreign language certification course offered by INSTITUTE/NPTEL/SWAYAM. They can take this certification course anytime from 3rd - 8th semester. To encourage the students to write competitive exams, TOEFL/IELTS qualified certificate will also be considered. The prescribed credit shall be included in 8th semester. The certification shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the certification shall be declared fail and shall have to complete during subsequent semesters.

Course Outcome (COs)

At the end of the course, the student will be able to		Learning Level	PO(s)
1.	develop vocabulary and improve the accuracy in grammar	L3	PO10
2.	improve LSRW- listening, speaking, reading and writing skills	L3	PO10
3.	speak with more confidence and enhance their professionalism at work	L3	PO10

- Certification course shall be evaluated for 25 marks as Internal Evaluation and no SEE.
- Internal Evaluation for a total of 25 marks will be awarded by the by the department committee. The scores are based on the performance evaluation done by the organisation offering the certification course.
- Student shall submit the copy of the assessment report and the certificate to the mentor/guide.

Course Code:18EC84	Professional Certification - 2	Total credits	1
Course type: PC	CIE Marks : 25 marks	SEE Marks	NIL

Students have to undergo 6-8 weeks of certification course offered by NPTEL/SWAYAM/NASSCOM /Industry-Institute partnered certification. They can take this certification course anytime from 3^{rd} – 8^{th} semester. The list of the online courses will be given by the departments. Also, to encourage the students to write competitive exams, GATE qualified certificate will also be considered. The prescribed credit shall be included in 8^{th} semester. The certification shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the certification shall be declared fail and shall have to complete during subsequent semesters.

Course Outcome (COs)

At the end of the course, the student will be able to		Learning Level	PO(s)
1.	acquire additional knowledge in current field	L2	PO12
2.	upskill themselves for the professional growth of their career	L3	PO12
3.	abreast with the new technologies in the industries and boost their competencies	L3	PO12

- Certification course shall be evaluated for 25 marks as Internal Evaluation and no SEE.
- Internal Evaluation for a total of 25 marks will be awarded by the by the department committee. The scores are based on the performance evaluation done by the organisation offering the certification course.
- Student shall submit the copy of the assessment report and the certificate to the mentor/guide.

Course Code: 18EC79/85/86/87	Project Work	Total credits	12

This course will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications. A single discipline or a multidisciplinary project can be assigned to an individual student or a group having not more than 4 students. Students can take it up in the same institute / out of the institute at reputed research organizations / Institutes/Industries. All the students shall have to select the project during 7th semester. A Viva-Voce examination shall be conducted during 7th/8th semester and the prescribed credit shall be included in 7th/8th semester. The project work shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent semesters whenever this course is offered.

Progress of the project work is monitored and evaluated in four phases as:

- 7th semester: Project Phase -1,
- 8th semester: Project Phase -2, Project Phase -3, and Project Phase - 4 (Final viva voce).

Course Outcome (COs)

At the end of the course, the student will be able to		Learning Level	PO(s)
1.	Identify, analyze and formulate projects with a comprehensive and systematic approach.	L4	PO2
2.	Summarize the literature review, analyze previous work and relate them to current project.	L4	PO2, PO4
3.	Use and apply fundamental knowledge and skills in engineering on the project.	L3	PO1
4.	Use of modern tools (software/hardware) which are applicable to the industries.	L3	PO5, PO12
5.	Design and develop a functional product/prototype/software while working in a team.	L6	PO3, PO6, PO7, PO8
6.	Working efficiently and constructively in a project team.	L3	PO 9
7.	Present the objectives, methodology and results using good oral and written presentation skills.	L3	PO 10, PO11

Scheme of Continuous Internal Evaluation

Continuous Internal Evaluation is done by the project guide and the project evaluation committee nominated by the department. Evaluation is based on the relevance to the project, objectives, work done and the presentation (in the form of report and oral presentation).

Semester	Component	Guide marks	Project Evaluation Committee marks	Total marks
7th	Project Phase - 1: Seminar on Project synopsis		25	25
8th	Project Phase - 2	25	25	50
8th	Project Phase - 3	25	25	50

Semester End Examination:

Semester	Component	Total marks
8th	Project Phase - 4: Brief Write-up, Project Presentation and Project Viva Voce	100