JSS MAHAVIDYAPEETHA

JSS SCIENCE & TECHNOLOGY UNIVERSITY, MYSURU

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF I TO VIII SEMESTER

2020 Batch

Syllabus of 1st to 8th Semesters

Scheme of Teaching and Examination for B.E (E&CE)

- Constituent College of JSS Science and Technology University
- Approved by A.I.C.T.E
- Governed by the Grant-in-Aid Rules of Government of Karnataka
- Identified as lead institution for World Bank Assistance under TEQIP Scheme

Vision

1. **Advancing JSS S&T University as a leader in education, research and technology on the international arena.**
2. **To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.**
3. **Accomplishing JSS S&T University as an epicentre for innovation, centre of excellence for research with state of the art lab facilities.**
4. **Fostering an erudite, professional forum for researchers and industrialist to coexist and to work cohesively for the growth and development of science and technology for betterment of society.**

Mission

1. **Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio economic conditions of the country.**
2. **Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which are strongly supported with interdisciplinary research and academia.**
3. **JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.**
4. **JSS S&T University core mission is to create knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.**

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Vision statement of the department of E&CE

Be a leader in providing globally acceptable education in electronics and communication engineering with emphasis on fundamentals-to-applications, creative-thinking, research and career-building.

Mission statement of the department of E&CE

1. **To provide best infrastructure and up-to-date curriculum with a conducive learning environment.**
2. **To enable students to keep pace with emerging trends in Electronics and Communication Engineering.**
3. **To establish strong industry participation and encourage student entrepreneurship.**
4. **To promote socially relevant eco-friendly technologies and inculcate inclusive innovation activities.**

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Semester Wise Credits

Semester	Credits	Total Marks
I	20	800
II	20	750
III	25	850*
IV	25	850*
V	25	850
VI	25	900
VII	19	600
VIII	16	300
Total	**175**	**5900****

***For lateral entry students, total marks for III semester 900 and IV semester 900**
****For lateral entry students total marks will be 4450**

Grading System

Marks	Grade
90 – 100	**S**
75 – 89	**A**
66 – 74	**B**
56 – 65	**C**
50 – 55	**D**
45 – 49	**E**
< 45	**F**

Notation in the Scheme

CIE	**Continuous Internal Evaluation**
SEE	**Semester End Examination**
L	**Lecture**
T	**Tutorial**
P	**Practical**

2 a. PROGRAM OUTCOMES (POs)

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

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

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.

4. **Conduct investigations of complex problems**: Using research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of 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 contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

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.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of 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. **Lifelong 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. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

2b. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To enable the graduates to have strong Engineering fundamentals in Electronics & Communication, with adequate orientation to mathematics and basic sciences.

2. To empower graduates to formulate, analyze, design and provide innovative solutions in Electronics & Communication, for real life problems.

3. To ensure that graduates have adequate exposure to research and emerging technologies through industry interaction and to inculcate professional and ethical values.

4. To nurture required skill sets to enable graduates to pursue successful professional career in industry, higher education, competitive exams and entrepreneurship.

2c. PROGRAM SPECIFIC OUTCOMES (PSO'S)

1. Analyze, design and provide engineering solutions in the areas of electronic circuits and systems.

2. Demonstrate the mathematical modeling techniques, nurture analytical and computational skills to provide engineering solutions in the areas of electronics and communication.

3. Ability to address multidisciplinary research challenges and nurture entrepreneurship.

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Scheme of Teaching and Examination 2020-21

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year2020-21)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN (I - Year)

Scheme of Teaching and Examination for I semester (Chemistry Cycle) B.E

SEMESTER: I

Sl. No.	Subject /Course Code	Subject / Course Title	Teaching Department	Contact Hours				CREDITS	Marks			Exam Duration Hours
				L	T	P	TOTAL		CIE	SEE	TOTAL	
1	20MA110	Engineering Mathematics- I	Mathematics	3	2	0	5	4	50	50	100	3
2	20CH110	Engineering Chemistry	Chemistry	3	2	0	5	4	50	50	100	3
3	20CV110	Engineering Mechanics	Civil	3	0	0	3	3	50	50	100	3
4	20EC110	Elements of Electronics Engineering	ECE	3	0	0	3	3	50	50	100	3
5	20ME120	Engineering Graphics and Design	Mechanical	0	2	3	5	2.5	50	50	100	3
6	20CH12L	Engineering Chemistry Laboratory	Chemistry	0	0	3	3	1.5	50	50	100	3
7	20HU120	Innovation studies	Parent / Any Eng. Depts.	0	2	0	2	1	50	50	100	1.5
8	20HU130	Functional English	Humanities	0	2	0	2	1	50	50	100	1.5
							28	**20**	**Total Marks**		**800**	

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN (I - Year)

Scheme of Teaching and Examination for II semester (Physics Cycle) B.E

SEMESTER: II

Sl. No.	Subject /Course Code	Subject / Course Title	Teaching Department	Contact Hours				CREDITS	Marks			Exam Duration Hours
				L	T	P	TOTAL		CIE	SEE	TOTAL	
1	20MA220	Engineering Mathematics- 2	Mathematics	3	2	0	5	4	50	50	100	3
2	20PH210	Engineering Physics	Physics	3	2	0	5	4	50	50	100	3
3	20ME210	Elements of Mechanical Engineering	Mechanical	3	0	0	3	3	50	50	100	3
4	20EC210	Elements of Electronics Engineering	ECE	3	0	0	3	3	50	50	100	3
5	20CS220	Introduction to Programming	CSE / ISE	3	0	0	3	3	50	50	100	3
6	20PH22L	Engineering Physics Laboratory	Physics	0	0	3	3	1.5	50	50	100	3
7	20CS22L	Computational Programming Laboratory	CSE / ISE	0	0	3	3	1.5	50	50	100	1Hrs30Min.
8	20HU210	Kannada	Humanities	2	0	0	2	0	50	-	50	-
							27	**20**	**Total Marks**		**750**	

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - II - Year

SEMESTER: III

Sl. No	Subject code	Course title	Category Code	Teaching Department	QP Setting Dept.	Contact Hours				Credits	Marks			Exam duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20MA310	Engineering Mathematics-III	BSC	Mathematics	Mathematics	3	0	0	3	3	50	50	100	03
	20MATDIP310	Advanced Mathematics-I	BSC	Mathematics	Mathematics	3	0	0	3	0	0	50	50	03
2	20EC310	Circuit Theory and Analysis	PCC	ECE	ECE	3	2	0	5	4	50	50	100	03
3	20EC320	Sensors and Actuators	PCC	ECE	ECE	3	0	0	3	3	50	50	100	03
4	20EC330	Analog Electronic Circuits	PCC	ECE	ECE	3	0	2	5	4	50	50	100	03
5	20EC340	Digital System Design	PCC	ECE	ECE	3	0	0	3	3	50	50	100	03
6	20EC350	Communication Systems -I	PCC	ECE	ECE	3	0	0	3	3	50	50	100	03
7	20HU311	Universal Human Values (UHV)	HSMC	ECE	HSMC	2	0	0	2	2	25	25	50	1.5
8	20EC37L	Digital System Design Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
9	20EC38L	Hardware System Integration and Simulation Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
		Total							30*	25	Total marks		850**	

Note: For lateral entry students the *contact hours will be 33 and ** total marks will be 900.

- **Environmental Studies course will be offered for the Programs with Physics Cycle of I Semester in 3rd Semester and in 4th semester in programs with Chemistry Cycle of I Semester.**
- **Universal Human Values course will be offered for the Programs with Chemistry Cycle of I Semester in third Semester (4th Semester of programs with Physics Cycle in I Semester).**
- **Credit calculation with UHV Course: 4 credits x 2 subjects + 3 credits x 4 subjects+ 2 Credits (HUV) +1.5 credits x 2 labs = 25.**
- **** 20HU311 is offered in 3rd Semester and hence the total marks are 850**

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - II - Year

SEMESTER: IV

Sl. No	Subject code	Course title	Category Code	Teaching Department	QP Setting Dept.	Contact Hours				Credits	Marks			Exam duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20MA410	Engineering Mathematics IV	BSC	Mathematics	Mathematics	3	0	0	3	3	50	50	100	03
	20MATDIP410	Advanced Mathematics-II	BSC	Mathematics	Mathematics	3	0	0	3	0	0	50	50	03
2	20EC410	Linear Integrated Circuits	PCC	ECE	ECE	3	0	2	5	4	50	50	100	03
3	20EC420	Microcontrollers and Embedded System	PCC	ECE	ECE	4	0	0	4	4	50	50	100	03
4	20EC430	Signals and Systems	PCC	ECE	ECE	3	2	0	5	4	50	50	100	03
5	20EC440	Communication Systems II	PCC	ECE	ECE	3	0	0	3	3	50	50	100	03
6	20EC450	Engineering Electromagnetics	PCC	ECE	ECE	4	0	0	4	4	50	50	100	03
7	20EC47L	Communication Lab I	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
8	20EC48L	Microcontrollers and Embedded System Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
9	20HU412	Environmental studies***	HSMC	ENV	ENV	2	0	0	2	0	50	--	50	--
		Total							32*	25	Total marks		850**	

Note: For lateral entry students the *contact hours will be 35 and ** total marks will be 900.

- *****Environmental Studies course will be offered for the Programs with Chemistry Cycle (I Semester) in 4th Semester (Physics Cycle (I Semester) in 3rd Semester).**
- **** 20HU412 will be offered in 3rd Semester and hence the total marks are 850**

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - III - Year

SEMESTER: V

Sl. No	Subject code	Course title	Category Code	Teaching department	QP Setting Dept.	Contact Hours				Credits	Marks			SEE Duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20EC510	Linear Algebra and Applications	PCC	ECE	ECE	3	2	0	5	4	50	50	100	03
2	20EC520	Microwave and Antennas	PCC	ECE	ECE	4	0	0	4	4	50	50	100	03
3	20EC530	Control Systems	PCC	ECE	ECE	3	2	0	5	4	50	50	100	03
4	20EC540	Digital Signal Processing	PCC	ECE	ECE	3	2	0	5	4	50	50	100	03
5	20EC55x	Professional Elective-I	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
6	20XX56x	Open Elective-I	OEC	ECE	ECE	3	0	0	3	3	50	50	100	03
7	20EC57L	Digital Signal Processing Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
8	20EC58L	Communication Lab II	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
9	20HU511	Essence of Indian Knowledge Tradition	HSMC	Humanities	HSMC	2	0	0	2	0	50	-	50	-
		Total							33	25	Total marks		850	

Note:

- **Open elective is open to all the students excluding the students of parent program.**
- **Essence of Indian traditional knowledge course will be offered for the Programs with Chemistry Cycle (I Semester) in 5th Semester (programs with Physics Cycle (I Semester) in 6th Semester).**
- **Credit calculation: 4 credits x 4 subjects + 3 credits x 2 subjects + 1.5 credits x 2 labs = 25**

Professional Elective-I			
20EC551	Solid State Electronics	**20EC554**	Smart Electronics materials
20EC552	Neural Networks and Machine Learning	**20EC555**	Data structures and Algorithm
20EC553	Principles of wireless communication systems		

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SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - III - Year

SEMESTER: VI

Sl. No	Subject code	Course title	Category Code	Teaching department	QP Setting Dept.	Contact Hours				Credits	Marks			SEE Duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20EC610	Information Theory and Coding	PCC	ECE	ECE	4	0	0	4	4	50	50	100	03
2	20EC620	Computer Networks	PCC	ECE	ECE	4	0	0	4	4	50	50	100	03
3	20EC630	CMOS VLSI Circuits	PCC	ECE	ECE	3	0	0	3	3	50	50	100	03
4	20EC64x	Professional Elective-II	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
5	20XX65x	Open Elective-II	OEC	ECE	ECE	3	0	0	3	3	50	50	100	03
6	20XX66x	Open Elective-III	OEC	ECE	ECE	3	0	0	3	3	50	50	100	03
7	20EC67L	CMOS VLSI Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
8	20EC68L	Networking - Lab	PCC	ECE	ECE	0	0	3	3	1.5	50	50	100	03
9	20EC69P	Design and Implementation Lab (Mini Project)	PWC	ECE	ECE	0	0	4	4	2	50	--	50	--
10	20HU612	Constitution of India and Professional Ethics	HSMC	Humanities	HSMC	2	0	0	2	--	50	--	50	--
		Total							32	25	Total marks		900	

Note:

- **Open elective is open to all the students excluding the students of parent program.**
- **Essence of Constitution of India course will be offered for the Programs with Chemistry Cycle (I Semester) in 6th Semester (Physics Cycle (I Semester) in 5th Semester).**
- **Team Size for Mini project can be between 1 – 4 students.**

Professional Elective-II			
20EC641	Robotics and Computer Vision	**20EC644**	Digital Image Processing
20EC642	Nanodielectrics: Challenges and Opportunities	**20EC645**	Mechatronics
20EC643	Modern Wireless Communication systems	**20EC646**	Operating Systems
		20EC647	Automotive Cyber Security

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - IV - Year

SEMESTER: VII

Sl. No	Subject code	Course title	Category Code	Teaching department	QP Setting Dept.	Contact Hours				Credits	Marks			SEE Duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20EC710	Innovation, Entrepreneurship and Management	HSMC	ECE	ECE	4	0	0	4	4	50	50	100	03
2	20EC72x	Professional Elective-III	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
3	20EC73x	Professional Elective-IV	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
4	20XX74x	Open Elective-IV	OEC	ECE	ECE	3	0	0	3	3	50	50	100	03
5	20XX75x	Open Elective-V	OEC	ECE	ECE	3	0	0	3	3	50	50	100	03
6	20EC76P	Project Work Phase - 1	PWC	ECE		--	--	4	4	2	50	--	50	--
7	20EC77P	Industrial training /Internship	PWC	ECE		0	0	2	2	1	50	--	50	--
									22	19	Total marks		600	

Note:

- **Students can take SWAYAM courses from 3rd semester to 6th semester and qualification certificate is to be submitted to the department before the commencement of 7th semester for considering in Professional elective IV* offered in 7th Semester.**
- **HOD's shall be preparing list of subjects offered under SWAYAM and it should be minimum of 12 weeks (12weeks or 8+4 or 4+4+4 or any other combination).**
- **Students who could not qualify/ complete the SWAYAM course from 3rd to 6th semesters should register for professional elective-IV in 7th semester.**
- **Open elective is open to all the students excluding the students of parent program.**
- **Classes for 7th Semester preferred to be conducted only on Thursday to Saturday to encourage students to undergo internship in the Industry from Monday to Wednesday (Internship/Industrial Training).**
- **Students can take mini project or industrial training or internship (any one). A guide should be allotted to each student/ group at the department level to monitor the progress.**

Professional Elective-III		Professional elective-IV*	
20EC721	Speech Processing using Deep Learning	**20EC731**	Nanoscience and Technology
20EC722	Embedded Systems	**20EC732**	Statistical Signal Detection and Processing
20EC723	Internet of Things (IoT)	**20EC733**	Cryptography and Network Security
20EC724	Quantum computing and Communication	**20EC734**	Wavelet and compression techniques
20EC725	Bio Medical Signal Processing	**20EC735**	Advanced Computer Networks
20EC726	Protocol Engineering and Technology	**20EC736**	Deep Learning for Computer Vision

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SCHEME OF TEACHING AND EXAMINATION FOR B.E. IN - IV - Year

SEMESTER: VIII

Sl. No	Subject code	Course title	Category Code	Teaching department	QP Setting Dept.	Contact Hours				Credits	Marks			SEE Duration in hrs.
						L	T	P	TOTAL		CIE	SEE	Total	
1	20EC81x	Professional Elective-V	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
2	20EC82x	Professional Elective-VI	PEC	ECE	ECE	3	0	0	3	3	50	50	100	03
3	20EC83P	Project work Phase - 2	PWC			--	--	20	20	10	70	30	100	03
		Total							26	16	Total marks		300	

Note:

1. **The evaluation of the project work phase-2 shall be done in four phases. 70 % weight age shall be given for the performance of the student in 1st (20 Marks), 2nd (20 Marks) and 3rd phases (30 Marks) evaluation (CIE) and 30 Marks for 4th phase evaluation (SEE).**
2. **Project Evaluation (Phase 1,2&3) should be done at the department Level Immediately after the 1st, 2nd and 3rd Theory test respectively.**
3. **Three-member committee will be formed (including the guide) at the department level to evaluate the project progress in phase 1, 2 & 3. This same committee will evaluate and finalize the CIE in all the phases. (Committee should remain same except for special cases).**
4. **Project team size can be 1-4.**
5. **Classes for 8th Semester preferred to be conducted only on Saturdays from 7.30AM to 1.30PM. Students should be allowed to work in the Industry from Monday to Friday (Internship), which may or may not be linked to the Project Work.**

	Professional Elective-V		Professional Elective-VI
20EC811	Automotive Electronics	**20EC821**	Low power VLSI
20EC812	Cloud Computing	**20EC822**	Mobile Computing
20EC813	Digital Compression Techniques	**20EC823**	Assistive Technology
20EC814	Advanced Embedded System	**20EC824**	Advanced Vehicular Network
20EC815	Operations Research	**20EC825**	Optical Networks and Sensors

Category Code:

BSC – Basic Science Course
ESC – Engineering Science Course
PCC – Professional Core Course (Including Laboratory subjects)
PEC – Professional Elective Course
OEC – Open Elective Course
HSMC– Humanities Social Science and Management Course
PWC – Project Work Course

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List of SWAYAM Courses identified by the department (for Professional Elective – IV): (Students can complete 12 Weeks of SWAYAM course/s between 3-6th Semester to claim exemption for Professional Elective - IV)

(Note: Student can take any of SWAYAM course in the following list or any other SWAYAM course after taking approval from HOD)

Sl. No.	SWAYAM Course Title	No of Weeks
1	Optical Communications	12 Weeks
2	Research Methodology and Statistical Analysis	
3	Sustainability Science	
4	Advanced Engineering Mathematics	
5	Electric Vehicles and Renewable Energy	
6	Integrated Photonics Devices and Circuits	
7	Linux Bash	
8	Linux Operating System	
9	SCILAB	
10	Introduction to Photonics	
11	Integrated Photonics Devices and Circuits	
12	Introduction to Medical Imaging Systems	
13	Integrated Circuits, MOSFETS, Op-amps and their Applications	
14	Applied Electromagnetics for Engineers	
15	Fabrication Techniques for MEMS based Sensors	
16	Linear Systems	
17	Mathematical Aspects of Biomedical Electronics	
18	Academic Research & Report Writing	8 Weeks
19	Power Quality Improvement Technique	
20	Robotics and Control : Theory and Practice	
21	A brief course on Superconductivity	4 Weeks
22	A brief introduction of Micro - Sensors	
23	C Programming and Assembly Language	
24	Introduction to probability and Statistics	
25	Patent Drafting for Beginners	

List of open electives offered by the department of Electronics and Communication Engineering

Sl. No.	Semester :elective	Course Code	Course Title
1	5: Open Elective – 1	20EC561OE	CMOS VLSI Circuits
2		20EC562OE	Sensors and Actuators
3		20EC563OE	Wireless Communication
4		20EC564OE	Control Systems
5		20EC565OE	Smart Materials
6	6: Open Elective – 2	20EC651OE	Nanoscience and Technology
7		20EC652OE	Automotive Electronics
8		20EC653OE	Smart Agricultural Technology
9		20EC654OE	Low power VLSI
10		20EC655OE	Artificial Intelligence and Deep Learning
11	6: Open Elective – 3	20EC661OE	Bioelectronics and Biosensors
12		20EC662OE	Optimization Techniques for Engineers
13		20EC663OE	Professional Communication and technical Report Writing.
14		20EC664OE	Verilog HDL
15		20EC665OE	Power Electronics
16	7: Open Elective – 4	20EC741OE	Product Design and development
17		20EC742OE	Hybrid Vehicles
18		20EC743OE	Deep learning for NLP
19		20EC744OE	ASIC
20		20EC745OE	Embedded Systems
21	7: Open Elective - 5	20EC751OE	Analog and Mixed Mode VLSI
22		20EC752OE	Wireless Sensor Networks
23		20EC753OE	Mobile Computing
24		20EC754OE	Robotics and Computer Vision
25		20EC755OE	Industrial Automation
26		20EC756OE	Telecommunication System Modeling and simulation

JSS MAHAVIDYAPEETHA

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

Scheme of Teaching and Examination 2020-21

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year2020-21)

Subject Break up of credits AICTE / Adapted

Sl. No.	Category	Suggested break up of credits	
		AICTE	Adapted scheme
1.	Humanities & Social Sciences including Management courses	12	08
2.	Basic Science courses	25	25
3.	Engineering Science courses	24	23
4.	Professional core courses	48	70
5.	Professional elective courses	18	18
6.	Open electives	18	15
7.	Project work/internship/seminar	15	15
8.	Mandatory courses (noncredit)	3 non-credit courses	Same courses are offered
Total		160	175

Distribution of Credits among various Curricular Components

Curricular Components /Semester	I	II	III	IV	V	VI	VII	VIII	Course Total	Percentage
Humanities and Social Sciences, Management (HS)	1	1	2				4		8	4.57 %
Basic Science (BS)	9.5	9.5	3	3					25	14.28%
Engineering Science (ES)	9.5	9.5							19	10.85%
Professional Core (PC)			20	22	19	14			75	42.85 %
Professional Elective (PE)					3	3	6	6	18	10.28%
Open Elective (OE)					3	6	6		15	8.57%
Project / Mini Project(P)						2	2	10	14	8.00 %
Seminar – Internship(S)							1		1	0.57 %
Non Credit Mandatory (NC)				1	1	1				0
Total Credits	20	20	25.0	25.0	25.0	25.0	19.0	16.0	175	99.97%*

Course Title: Elements of Electronics Engineering	***Course Code: 20EC110 / 20EC210***
Credits :3	***Total Contact Hours (L:T:P): 40:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Course Outcomes: After completing this course, students should be able to:

CO1:	List the characteristics of electronic devices.
CO2:	Describe the working of devices, circuits and equipment's.
CO3:	Apply the concepts to realize analog and digital circuits.
CO4:	Analyze the need of devices and equipment's for particular application.

Unit No.	Course Content	No. of Hours
1	**Analog Electronics:** Diode characteristics with load line and its application- rectifiers, Clipper and clamper, working principles of Zener and photo diodes, BJT characteristics with load line and applications - switch and amplifier, JFET and MOSFET Characteristics and its applications.	08
2	**Digital Electronics:** Binary arithmetic's operation, Basic and universal Logic Gates, simplification and realization of Boolean expression (SOP, POS), combinational and sequential logic.	08
3	**Integrated Circuits:** Differential amplifiers, Op-amps and its application, IC regulators, Digital IC, Timers Circuits.	08
4	**Communication Basics:** Introduction, EM spectrum and Applications, Modulation & its types, Principles of wireless communication, Computer communication, MODEM.	08
5	**Devices and Equipment's:** Signal generator, CRO, SMPS, Multimeter, OLED, LCD and IOT based devices, Microwave Oven, Processor and Microcontroller, Different types of sensors and Actuators.	08

Text Book:

1. **Robert Boyelstad**: "*Electronic Devices and circuit theory*", 11th Edition, Pearson, 2015.
2. **Ramakant A. Gayakwad**, "*Op-Amps and Linear Integrated Circuits*", 4th Edition, Pearson, 2015

Reference Books:

1. **Floydand Jain,** "*Digital Fundamentals*", 11th Edition, Pearson, 2017.
2. **B.P.Lathi and ZhiDing**, *"Modern Digital And Analog Communication Systems"*, 4th Edition (Paperback) South Asia edition, Oxford 2017..

E-Resource:

1 http://www.freebookcentre.net/Electronics/Communication-Books.html
2 http://www.freebookcentre.net/Electronics/Devicesandequipments-Books.html
3 http://nptel.ac.in/courses/108102095/

CO-PO Mapping (Course Articulation Matrix):

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012
CO1	3	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0
CO4	0	0	2	0	2	0	0	0	2	2	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Engineering Mathematics-III	***Course Code: 20MA310***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Basic Science***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Engineering Mathematics-I and II.

Course Outcomes: After completing this course, students should be able to:

CO1:	Apply least square method to fit a curve for the given data and evaluate the correlation coefficient and regression lines for the data.
CO2:	Determine the nature of the events and hence calculate the appropriate probabilities of the events.
CO3:	Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations.
CO4:	Apply numerical techniques to solve Engineering problems and fit a least squares curve to the given data.
CO5:	Construct the Fourier series expansion of afunction/tabulated data.

Unit No.	Course Content	No. of Hours
1	**Statistics:** Introduction, Definitions, Curve Fitting, equation of Straight line, parabola and exponential, correlation and regression, formula for correlation coefficient, regression lines and angle between the regression lines.	08
2	**Random Variable:** Discrete Probability distribution, Continuous Probability distribution, expectation, Variance, Moments, Moment generating function, Probability generating function, Binomial distribution, Poisson distribution, Normal distribution and Exponential distributions.	08
3	**Partial differential equations (P.D.E.):** Formation of Partial Differential Equation, Solution of Lagrange's Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. **Applications of P.D.E.:** Classification of PDE, solution of one dimensional heat and wave, two dimensional Laplace's equation by the method of separation of variables.	08
4	**Numerical solution of Ordinary differential equations:** Taylor's series method, Euler's and modified Euler's method, fourth order Runge-Kutta method**.**	07
5	**Fourier Series:** Periodic functions, Fourier Expansions, Half Range Expansions, Complex form of Fourier series, Practical Harmonic Analysis	08

Text Book:

1. **B.S.Grewal,** "*Higher Engineering Mathematics*", 43rd edition, Khanna Publications, 2015.
2. **Ramana .B.V**, **"***Higher Engineering Mathematics*"**,** latest edition,Tata-McGraw Hill, 2016

Reference Books:

3. **C. Ray Wylie and Louis C. Barrett,** "*Advanced Engineering Mathematics*", 6th edition, Tata-McGraw Hill 2005.
4. **Louis A. Pipes and Lawrence R. Harvill,** "*Applied Mathematics for Engineers and Physicists*", 3rd edition, McGraw Hill 2014.
5. **Erwin Kreyszig,** "*Advanced Engineering Mathematics*" , 10th edition, Wiley Publications, 2015

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes:

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO4	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO5	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Circuit Theory and Analysis	***Course Code: 20EC310***
Credits : 4	***Total Contact Hours (L:T:P): 39:26:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Ohm's law, Kirchoff's voltage and current law, equivalent resistance in parallel and series combination of resistors, mathematical operations of complex numbers, active and passive components.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamentals of network terminologies and concepts essential for problem solving.
CO2:	Analyze the network theorems to solve for the given AC/DC circuits.
CO3:	Solve the given network/circuit problems using circuit analysis techniques.
CO4:	Demonstrate the skill sets using software tools for simulation of circuit problems.

Unit No.	Course Content	No. of Hours
1	**Basic concepts:** Introduction, Network terminologies, Energy sources – ideal and practical, Mesh Analysis of DC and AC circuits, Circuits with independent voltage sources only Mesh analysis – circuits containing independent current sources and dependent sources, Concept of super mesh, Nodal analysis - Circuits containing independent current sources, Nodal analysis – circuits containing dependent sources, Concept of super node, Star – Delta transformations and network reduction using them, Source transformations and related problems.	8
2	**Network Theorems:** Superposition theorem, problems. Thevenin's theorem as applied to AC and DC circuits, Norton's theorem as applied to DC and AC circuits, Maximum power transfer theorem as applied to DC and AC circuits, Mill man's theorem, applications and problems.	8
3	**Resonance and Initial Conditions:** Series resonance, resonant frequency, reactance curves, voltage and current variable with frequency, Selectivity and bandwidth, Q – factor, circuit magnification factor Selectivity with variable C and variable L Parallel resonance, resonant frequency, impedance, selectivity, bandwidth Maximum impedance conditions with C, L, and f variable, current and Q – factor. Need for Initial conditions in R, L, and C elements. Final conditions and Geometrical interpretation of derivatives, Procedure to evaluate initial conditions. Initial state of a network.	8
4	**Circuit Analysis using Laplace Transforms and Fourier series:** Review of Laplace transforms, Natural and Forced responses, Advantages of LT techniques, Modeling R, L, and C in s – domain, DC transients, Step response of RC, RL and RLC circuits, Impulse and Pulse response of RC and RL circuits and AC transients, Circuit analysis with LT using partial fraction expansion and convolution integral. Applications of Fourier techniques to circuit analysis, Waveform symmetry, Line spectrum, Waveform synthesis Effective value and power, problems, Application of FS in circuit Analysis.	8
5	**Network Functions and Two Port parameters:** Concept of complex frequency, Network functions for one and two – port networks. Poles and zeros of network functions, Restrictions on pole and zero locations for driving	7

	point functions and transfer functions, Time domain behavior from pole – zero plots. Short – Circuit admittance parameters, Open circuit impedance parameters, Transmission parameters, Hybrid parameters, problems, Relationships between parameters, problems.	

Text Books:

1. **Charles K Alexander, Mathew N. O. Sadiku,** "*Fundamentals of Electric Circuits*" 5th Edition, McGraw Hill Education (India) Pvt Ltd New Delhi, Reprint 2016.
2. **J. David Irwin, Robert M Nelms,** "*Engineering Circuit Analysis*", 10 Edition, Wiley India Pvt Ltd, Reprint 2013.

Reference Books:

1. **M.E.VanValkenburg:**"*Network Analysis*", 3rd edition, Pearson/ PHI, Reprint 2006.
2. **D. Roy Choudhury:** "*Networks and Systems*", New Age International, Reprint 2005.

Web Resources:

1. https://nptel.ac.in/courses/108102042/3
2. https://nptel.ac.in/courses/117106108
3. https://play.google.com/store/apps/details?id=com.education.nptelee&hl=en

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
CO4	2	0	0	2	3	2	0	2	2	3	2	2	0	0	2
Avg	2	3	3	2	3	2	0	2	2	3	2	2	2	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Sensors and Actuators	***Course Code: 20EC320***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the working principle of transducers, sensors and actuators.
CO2:	Apply the basic knowledge of sensors and actuators in solving and designing an instrumentation system.
CO3:	Analyze the applications of transducers, smart sensors and actuators.
CO4:	Demonstrate suitable sensors and transducers for real time applications.

Unit No.	Course Content	No. of Hours
1	**Instrumentation system and Transducers:** Introduction, generalized functional block diagram, input output configuration, Advantages of Electronic measurement, Errors in measurement, Types of Errors, static characteristics, dynamic characteristics, calibration and standards, process of calibration. Transducers, Selecting a transducer, Electrical transducers, Resistive transducer, Resistive position transducer, Strain gauges.	8
2	**Analog Sensors and Transducers:** Introduction, principles, classification, characterization, Shaft Encoders, Incremental Optical Encoder, Variable-Inductance Transducers, Variable-Capacitance Transducers, Piezoelectric Sensors, Sensors for Electromechanical Applications, Photo emissive cells, Photoconductive cells – Measurement of physical quantities. Microsensors. Acoustic sensors, Ultrasonic based sensors.	8
3	**Actuators:** Introduction, Functional components of an actuator, Actuator as a system component, Intelligent & Self sensing actuators, microactuation, MEMS with microactuators, piezoelectric actuators, Application examples (Automatic anti-lock braking systems).	8
4	**Smart Sensors:** Smart sensors: Introduction Primary Sensors, Information coding / processing, Data communication, automation. Concept and architecture of intelligent sensors, onboard automobile sensors, home appliance sensors, biomedical application, Introduction to MEMS and Microsystems, Microsystems and Microelectronics Multidisciplinary nature of microsystem design and manufacture, applications of microsystems, Nano sensors.	8
5	**Interfacing Methods and Circuits:** Introduction, Amplifiers, Power Amplifiers, Digital Circuits, Bridge Circuits, Data Transmission, Noise and Interference.	7

SLE: Future Trends in Neurosensors, Biosensors, Nano-technology, Soft Computing techniques in instrumentation.

Text Books:

1. **Clarence W. de Silva,** "*Sensors and Actuators Engineering System Instrumentation*", CRC Press, 2nd Edition, 2016.
2. **D Patranabis,** "*Sensors and Transducers"* PHI Ltd, 2nd Ed, 2003.
3. **Tai-Ran Hsu**: "*MEMS & Microsystems Design and Manufacture*", Tata McGraw Hill, 2007.

4. **Nathan Ida:** "*Sensors, Actuators, and their Interfaces*", SciTech Publishing Inc, 2nd Edition, 2020.

Reference Books:

1. **H.S. Kalsi,** "*Electronic Instrumentation*", Tata McGraw-Hill, 3rd Ed, 2010.
2. **Stefan Johann Rupitsch**, "*Piezoelectric Sensors and Actuators": Fundamentals and Applications*, Springer-Verlag Berlin Heidelberg, 2019.
3. **Hartmut Janocha**, "*Actuators Basics and Applications*", Springer publication, 2013.
4. **D.V.S. Murthy**: "*Transducers and Instrumentation*", PHI Ltd, 2nd Ed, 2010.

Web Resources:

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.coursera.org/lecture/interface-with-arduino/lecture-2-1-actuators-uNCa4

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC320	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	2	0	0	3	3	0	0	0	3	0	0	2	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Analog Electronic Circuits	***Course Code: 20EC330***
Credits : 3:0:1	***Total Contact Hours (L:T:P): 39:0:20***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Elements of Electronics Engineering

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the working principle of various analog electronic circuits and explore their applications.
CO2:	Analyze the important relations for analog electronic circuits and interpret the results.
CO3:	Design analog electronic circuit for the given specifications.
CO4:	Demonstrate an analog electronic circuit for the given specifications.

Unit No.	Course Content	No. of Hours
1	**BJT amplifier circuits:** Introduction, BJT circuits at DC, small-signal operation and models, single-stage BJT amplifier, CE, CB & CC amplifiers, SPICE BJT model and simulation.	08
2	**MOS amplifier circuits:** Introduction, MOSFET circuits at DC, small-signal operation and models, single-stage MOS amplifier, CS, CG & CD amplifiers, SPICE FET model and simulation.	08
3	**Frequency Response:** General consideration, Low frequency response of BJT and MOSFET amplifiers, Miller's theorem,High frequency response of BJT and MOSFET amplifiers, SPICE simulation.	07
4	**Feedback amplifiers and Oscillators:** General feedback structure, negative feedback, feedback topologies, feedback amplifiers, loop gain and stability, phase shift oscillator, LC and crystal oscillator (BJT and FET based), SPICE simulation.	08
5	**Output stages and Power amplifiers:** Introduction, classification, Class A,B, AB, C output stage, Switched Mode Power Amplifiers, IC power amplifiers, CMOS class AB output stage, SPICE simulation.	08

Text Books:

1. **Adel S. Sedra and K. C. Smith,** "*Microelectronic Circuits*," $7^{th}/8^{th}$ Ed. 2018 Oxford University Press India.

Reference Books:

1. **Robert Boyelstad**, "*Electronic Devices and circuit theory*", 11th Edition, Pearson, 2015.
2. **Millman & Halkias**, "*Electronic Devices and Circuits*" 4th Edition, McGraw-Hill Education, 2015.
3. **U B Mahadevaswamy,** "*Analog Electronics Circuits*", Sanguine Publications, Revised Edition 2010.

Web Resources:

1. E-Book: http://www.freebookcentre.net/Electronics/Analog-Circuits-Books.html
2. Video Lecture: http://nptel.ac.in/courses/108102095/

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	2
CO4	3	3	3	3	3	0	0	0	3	0	0	3	3	3	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Integrated Course Lab Experiments:

Part A

1. Clippers and Clampers Circuits.
2. Rectifiers.
3. BJT characteristics.
4. MOSFET characteristics.
5. Frequency response of single stage RC – Coupled Amplifier.

Part B

6. RC – Low pass and High Pass filters.
7. BJT Darlington Emitter follower circuit.
8. Voltage series feedback amplifier.
9. Negative Feedback amplifier.
10. Oscillators.

Course Title: Digital System Design	***Course Code: 20EC340***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Integrated	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Elements of electronics engineering

Course Outcomes: After completing this course, students should be able to:

CO1	Explain the concept of combinational and sequential logic circuits.
CO2	Analyze the working of combinational and sequential logic circuits.
CO3	Design the combinational and sequential circuits for the given specifications.
CO4	Demonstrate the functionality of digital circuit/system using Verilog HDL

Unit No.	Course Content	No. of Hours
1	**Principles, Analysis and design of combinational logic:** Definition of combinational logic, canonical forms, Generation of Boolean expressions from truth tables, Karnaugh maps-3,4,5 variables. Decoders, Encoders, multiplexers, demultiplexers, Adders and subtractors, Look ahead carry, Binary comparators.	08
2	**Flip-Flops and its Applications:** Basic Bistable elements, Latches, master-slave flip-flops (pulse-triggered flip-flops): SR flip-flops, JK flip-flops, Characteristic equations, Registers, binary ripple counters, and synchronous **Sequential Circuit Design:** Design of a synchronous counter, synchronous mod-n counter using clocked JK and D, Design of a Sequence Detector **Sequential System:** Mealy and Moore models, State machine notation, Construction of state diagrams.	08
3	**Applications of Digital Circuits:** Guidelines for construction of state graphs, Design Example – Code Converter, Serial Adder with Accumulator, Design of Binary Multiplier, Design of Binary Divider. Design of Sequential Circuits using ROMs and PLAs, CPLDs and FPGAs..	08
4	**Verilog HDL Basic Concepts**: Lexical conventions, datatypes, system tasks, compiler directives. **Modules and Ports:** Module definition, port declaration, connecting ports, hierarchical name referencing. **Gate-Level Modeling:** Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays.	08
5	**Dataflow Modeling:** Continuous assignments, delay specification, expressions, operators, operands, operator types. **Behavioral Modeling:** Structured procedures, initial and always, blocking and non blocking statements, generate statement, conditional statements, loops, sequential and parallel blocks. **Tasks and Functions:** Differences between tasks and functions, declaration, invocation, automatic tasks and functions.	07

Text Books:

1. **John M Yarbrough,** -"*Digital Logic Applications and Design*", 1st Edition Thomson Learning,2006.

2. **Donald D. Givone,** - *"Digital Principles and Design"*, 1st Edition, McGraw Hill, 2003.
3. **Charles H Roth Jr.,Larry L. Kinney** – "*Fundamentals of Logic Design*", Cengage Learning, 7th Edition. 2020.
4. **Samir Palnitkar,** "*Verilog HDL: A Guide to Digital Design and Synthesis*", Pearson Education, Second Edition.

Reference Books:

1. **R D Sudhaker Samuel, —***"An Illustrative Approach to Logic Design"*,1st EditionPearson, 2010.
2. **Morris Mano**, —*"Digital Design"*, 6th Edition,Prentice Hall of India. 2018
3. **K. A. Navas**, —*"Electronics Lab Manual"*, Volume I, 5th Edition, PHI, 2015.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
CO4	3	3	3	3	2	2	0	0	2	0	0	2	0	0	2

0 -- No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Communication System-I	***Course Code: 20EC350***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: NIL or list of few subjects studied in previous semesters which makes pre requisite for this course.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the importance of electronic communication systems.
CO2:	Analyze and evaluate various analog modulation and demodulation techniques through analytical and simulation methods.
CO3:	Design and demonstrate the various frequency synthesis techniques.
CO4:	Demonstrate the working of analog communication system for the given application.

Unit No.	Course Content	No. of Hours
1	**Introduction**: Introduction to electronic communication systems, power measurement units, EM frequency spectrum, bandwidth and channel capacity and data rate, signal analysis and mixing, brief review of modern telecommunication system.	07
2	**AM Modulation and Demodulation:**analysis of signals, amplitude modulation and demodulation, generation of AM wave: square law modulator, switching modulator, detection of AM waves: square law detector, envelop detector. Double side band suppressed carrier modulation (DSBSC): Time - Domain description, Frequency - Domain representation. Generation of DSBSC waves: Balanced modulator, ring modulator. Coherent detection of DSBSC modulated waves. Costas loop.	08
3	**SSB generation and frequency synthesizers:**Quadrature carrier multiplexing, Hilbert transform, properties of Hilbert transform. SSB generation, frequency - domain description of SSB wave, mathematical analysis of suppressed carrier systems, SSB reception. SSB measurements and FDM.Generation of VSB modulated wave, frequency domain description of VSB wave. Comparison of amplitude modulation techniques, Phase lock loops. PLL capture and lock ranges, PLL loop gain, phase comparators and frequency synthesizers.	08
4	**FM modulation and Demodulation**: Basic definitions of FM, Deviation sensitivity, narrow band FM, wide band FM, transmission bandwidth of FM waves, generation of FM waves: Indirect FM and direct FM. Demodulation of FM waves: Balanced slope detector, Foster seeley discriminator.	08
5	**Noise Analysis** : Noise in communication system- noise analysis, equivalent noise temperature, and cascade connection of two port network, sampling and A/D conversion of signals, transmission band width and SNR, Multiplexing,	08

Text Books:

1. **Wayne Tomasi**– "*Electronic Communication Systems*" 5th edition, Pearson Education, 2007
2. **B. P. Lathi,** "*Modern digital and analog Communication systems*",4th edition, Oxford University Press, 2010,

Reference Books:

1. **Simon Haykins** "*Communication Systems*", 5th edition, John Wiley, 2009.
2. **Michael Fitz** "*Fundamentals of Communication Systems*", TMH, 2008 (for MATLAB exercises and mini projects)
3. **Sanjay Sharma** "*Analog Communication Systems*", 2nd edition, 2007

Web Resources:

1. https://nptel.ac.in/courses
2. https://nptel.ac.in/courses

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	3	0	0	0	3	0	0	0	3	3	3	2	3	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Universal Human Values	***Course Code: 20HU311***
Credits : 2:0:0	***Total Contact Hours (L:T:P): 26:0:0***
Type of Course: Theory	***Category: Humanities & Social Sciences including Management courses***
CIE Marks: 25	***SEE Marks: 25***

Pre-requisite: Students Induction Program (desirable).

Course Outcomes: After completing this course, students should be able to:

CO1:	Become more aware of themselves, and their surroundings (family, society, and nature); they would become more responsible in life, and in handling problems with sustainable solutions, keeping human relationships and human nature in mind.
CO2:	Have better critical ability and also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

Unit No.	Course Content	No. of Hours
1	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:** Recapitulation from Universal Human Values-I, Self-Exploration; 'Natural Acceptance' and Experiential Validation. A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.	05
2	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health.	05
3	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship:** Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family	05
4	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence:** Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature. Understanding Existence as Co-	05

	existence of mutually interacting units in all pervasive space. Holistic perception of harmony at all levels of existence.	
5	**Implications of the above Holistic Understanding of Harmony on Professional Ethics:** Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics. Case studies of typical holistic technologies. Strategy for transition from the present state to Universal Human Order	06

Text Books:

1. **R R Gaur, R Sangal, G P Bagaria,** "*Human Values and Professional Ethics*" Excel Books, New Delhi, 2010

Reference Books:

1. **A Nagaraj**, "*Jeevan Vidya: Ek Parichaya"*, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. **A.N. Tripathi,** "*Human Values*", New Age Intl. Publishers, New Delhi, 2004.
3. **Mohandas Karamchand Gandhi** "*The Story of My Experiments with Truth*"
4. **J C Kumarappa** "*Economy of Permanence*"

Web Resources:

1. https://onlineethics.org/

CO-PO Mapping (Course Articulation Matrix):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	0	1	2	2	0	0	0	0
CO2	0	0	0	0	0	1	1	1	0	0	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Digital System Design Lab	***Course Code: 20EC37L***
Credits : 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Elements of Electronics Engineering

Course Outcomes: After completing this course, students should be able to:

CO1:	Design the digital logic circuits as per the given specifications.
CO2:	Demonstrate the working of digital logic circuits using hardware components/Verilog HDL

EXP No.	**Course Content**	**No. of Hours**
1.	Design and implement of i) Adder/ subtractor using logic gates ii) 4-bit Parallel adder/Subtractor using IC 7483	3
2.	Design and implement of i) Code convertors., Design ii) One-bit comparator and Magnitude comparator using IC 7485.	3
3.	Design and implement of i. Mod-N synchronous/Asynchronous up and down counters using 7476 JK flip-flop IC. ii. Synchronous counter using IC 74192.	3
4.	Realize and implement the following shift registers using IC 7474/7495: SISO, SIPO, PISO, PIPO, Ring and Johnson counter.	3
5.	**SLE:** Design of Serial adder with accumulator and design of binary multiplier and division using software tool.	3
	Verilog HDL simulation lab experiments:	
6.	Design of 2-to-4 decoder, and 8-to-3 encoder (without and with parity)	3
7.	Design of 8-to-1 multiplexer and 1-to-8 de-multiplexer	3
8.	Design of 4 bit comparator and full adder using 3 modeling styles	3
9.	Design of flip flops: SR, D, JK, T	3
10.	Design of 4 bit binary, BCD counters (Synchronous/ asynchronous reset)	3

Course Outcomes	**Program Outcomes**												**PSO's**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	3	3						2			2	2		
CO2	3	3	3	3	2				2	2		2		2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Hardware Systems Integration and Simulation Lab	***Course Code: 20EC38L***
Credits: 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Basic Electronics**.**

Course Outcomes: After completing this course, students should be able to:

CO1:	Analyze hardware and software sub-systems and configure them for running the simulation.
CO2:	Demonstrate basic skills required for Printed Circuit Board (PCB) design and developmer

EXP No.	Course Content	No. of Hours
	PART-A: (Emphasis to Linux systems)	
1.	Essentials of PC Hardware (Hardware subsystems and technology)	3
2.	External interfaces to PC (Wired and Wireless)	3
3.	Command usage practice (user/admin/network level commands)	3
4.	Programming practice under Unix/Linux environment	3
	PART-B :(Emphasis to use Octave/Python software tools)	
5.	Compute and verify various mathematical operations, Matrix operations	3
6.	Compute and verify string operations, number system conversion and graphical plot commands.	3
7.	Simulate and verify branch currents and voltages in DC circuits.	3
8.	Simulate and verify branch currents and voltages in AC circuits	3
9.	Simulate and verify branch currents and voltages in transistor circuits.	3
	PART-C: PCB Design Skills	
10.	i. Design using CAD Tools ii. Etching Process in the Lab iii. Soldering and Testing of final PCB	3

Text Books:

1. **Syed Mansoor Sarwar, Robert M Koretsky,** "*Linux The Textbook*" CRC Press Second Edition – 2018
2. **Richard Fox, "***Linux with Operating System Concepts*" Taylor & Francis publisher 2014

Mapping Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	3	0	0	3	0	0	0	0	0	0	0	3	0	0
CO2	2	3	3	3	3	0	0	0	3	0	0	3	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

IV SEMESTER

Course Title: Engineering Mathematics-IV	***Course Code: 20MA410***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Basic Science***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Engineering mathematics 1, 2 & 3.

Course Outcomes: After completing this course, students shall be able to:

CO1:	Apply numerical techniques to solve Engineering problems and fit a least squares curve to the given data
CO2:	Evaluate Fourier transforms and use Z-transform to solve difference equations.
CO3:	Examine and construct the analytic functions.
CO4:	Classify singularities of complex functions andevaluate complex integrals.
CO5:	Ability to solve system of linear equations, carryout matrix operations, determines the eigenvalues & eigenvectors.

Unit No.	Course Content	No. of Hours
1	**Numerical Differentiation and Numerical Integration**: Derivatives using Newton-Gregory forward and backward interpolation formulae, Newton-Cotes quadrature formula, Trapezoidal rule, Simpson's1/3rd rule and Simpson's 3/8th rule. Applications to Engineering problems**.**	07
2	**Fourier Transforms:** Finite and Infinite Fourier transform, basic properties, convolution theorem; inverse transforms; **Z-transforms:** z-transforms and inverse z-transforms; solution of difference equation	08
3	**Complex Variables-I:** Functions of complex variables,Analytic function, Cauchy-Riemann equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann equations, Construction of analytic functions.	08
4	**Complex Variables-II:** Complex integration, Cauchy theorem, Cauchy integral formula, Taylor and Laurent series (statements only), Singularities, Poles and residues, Cauchy residue theorem.	08
5	**Linear Algebra:** System of linear equations, Row operations, Echelon form Reduced Echelon form, Solution of Homogeneous and Non homogeneous equations, vector equations, Linear combinations, Linear independent/dependent vectors, Eigen values, Eigen vectors, Diagonalizations, Solving a system of differential equations using diagonalization.	08

Text Books:

1 **B.S.Grewal,** "*Higher Engineering Mathematics*", 43rd edition, Khanna Publications, 2015.
2 **Ramana .B.V,** "*Higher Engineering Mathematics*", latest edition, Tata-McGraw Hill, 2016
3 **Ralph P. Grimaldi,** "*Discrete and Combinatorial Mathematics*", 4th Edition, PHI/Pearson Education, 2005.

Reference Books:

1 **Erwin Kreyszig,** "*Advanced Engineering Mathematics*", 10th edition, Wiley Publications, 2015.

2 **C. Ray Wylie and Louis C. Barrett**, "*Advanced Engineering Mathematics*", 6th edition, Tata-McGraw Hill 2005.

3 **Louis A. Pipes and Lawrence R. Harvill**, "*Applied Mathematics for Engineers and Physicists*", 3rd edition, McGraw Hill 2014.

4 **Ralph P. Grimaldi**, "*Discrete and Combinatorial Mathematics*", 4th Edition, PHI/Pearson Education, 2005

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO4	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO5	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Linear Integrated Circuits	***Course Code: 20EC410***
Credits : 3:0:1	***Total Contact Hours (L:T:P): 39:0:20***
Type of Course: Integrated Course	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Course Outcomes: After completing this course, students shall be able to:

CO1:	Explain the operation of linear integrated circuits and explore their applications.
CO2:	Analyze linear integrated circuits to obtain the voltage and current responses at different points and the frequency response.
CO3:	Design a linear integrated circuit for the given specification by applying the concepts of linear integrated circuit.
CO4:	Demonstrate the skill set for a given application / problem statement using linear ICs and EDA tools.

Unit No.	Course Content	No. of Hours
1	**Introduction to Operational Amplifiers andCharacteristics:** Introduction, Basic Information of Op-Amp, the ideal Operational Amplifier, Operational amplifier internal circuit, DC and AC characteristics, Inverting and non-inverting amplifiers, voltage follower.	08
2	**Op-Amp Applications I:** Summing Amplifiers**,** Instrumentation amplifier, V to I and I to V Converters, high resistance DC voltmeter, universal high resistance voltmeter, solar cell energy measurements, differentiator, integrator. **Active filters** - RC filters, State Variable filter, switched capacitor filters	10
3	**Op-Amp Applications II:** Comparator**,** Schmitt Trigger, Square/Rectangular and Triangular wave generators, sample and hold circuit, LOG and ALOG amplifiers,multiplier, divider and their applications.	07
4	**Op-Amp Applications III:** Precision rectifiers, peak detectors, dead-zone circuits, A to D and D to A Converters.	06
5	**Voltage Regulators and 555Timer:** Series op-amp regulator, IC voltage regulator, 723 general purpose regulator, Switching regulators, 555 Timer as Monostable and Astable Multivibrator.	08

Text Books:

1. **James M. Fiore:** *"Operational Amplifiers & Linear Integrated Circuits:Theory and Application"*Version 3.2.6, May 2021.
2. **Robert F Coughlin, Frederick F Driscoll:***"Operational Amplifiers & Linear Integrated Circuits*", Pearson India education services Pvt. Ltd,2017
3. **D. Roy Choudhary, Shail B. Jain:** *"Linear Integrated Circuits", New Academic Science,* 5th Edition, 2018.

Reference Books:

1. **David A. Bell:** "*Operational Amplifiers and Linear ICs*", 3rd Edition, Oxford university press, India, 2011.
2. **Ramakanth A. Gayakwad:** "*Op-Amps and Linear Integrated Circuits*", 4th Edition, Pearson India education services Pvt. Ltd, 2015
3. **S Rajaram, A Kandaswamy, M Alagappan, Arulalan Rajan,** *"Linear Integrated Circuits andits Applications"*, Texas Instruments

Web Resources:

1. EBook: https://docs.google.com/file/d/0B21HoBq6u9TsbG5WdjNZeGwtMWs/preview
2. Video Lecture: http://nptel.ac.in/courses/108106068/

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	3	3	3	3	2	2	0	0	2	0	0	2	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Lab Component

List of Experiments

1. Design and testing of Op-amp DC and AC amplifiers: Inverting amplifier, Non- inverting amplifier and Voltage follower.
2. Design and testing of Op-amp DC circuits: Adder, Subtractor, Difference amplifier, Average.
3. Design and testing of Op-amp integrator and differentiator.
4. Design and testing of Butterworth's Low pass and High pass filters.
5. Design and testing of Band pass and Band Elimination filters.
6. Design and testing of Schmitt Trigger Circuits.
7. Design and testing of Op -Amp Triangular and Rectangular Waveform Generators.
8. Design and testing of Voltage regulator.
9. Design and testing of 555 Timer Astable Multivibrator.
10. Simulation experiments:
    i. State variable and switched capacitor filter
    ii. Switching voltage regulator
    iii. Precision rectifiers

iv. Instrumentation amplifiers

v. Amplitude modulation using analog multiplier

Note: Design and simulate the opamp applications using appropriate tools.

Course Title: Microcontrollers and Embedded system	***Course Code: 20EC420***
Credits: 4	***Total Contact Hours (L:T:P): 52:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Programming in C and any programming language like Verilog, VHDL.

Course Outcomes: After completing this course, students shall be able to:

CO1:	Explain the basics of Embedded system, architecture of 8051 microcontroller and ARM cortex processor
CO2:	Develop programs using assembly language and embedded C.
CO3:	Design applications using 8051 and ARM Cortex
CO4:	Demonstrate the given problems using technological advancements.

Unit No.	Course Content	No. of Hours
1	**Introduction to Embedded Systems: Introduction to Embedded Systems:** Embedded systems- definition, classification of embedded systems, types of embedded systems, purpose of embedded systems. Elements of embedded systems – cores, firmware, sensors and actuators, bus systems, memory. Embedded SOC and use of VLSI Circuit Design Technology, Formalization of System Design, Design Process and Design Examples.	10
2	**8051 Microcontroller:-** Architecture, 8051 hardware, i/o and o/p pins, ports and port circuits, external memory, counters and timers, serial communication. **Addressing modes & instructions: -** Addressing modes, external data moves, code memory read only data moves, PUSH & POP op-codes, data exchanges, and arithmetic, logical, jump and call instructions.	10
3	**Timer/counter, serial communication and interrupt programming**:- Programming 8051 timer/counter, basics of serial communication, 8051 connection to RS 232, 8051 serial port programming, 8051 interrupts, programming timer interrupts, programming external hardware interrupts, programming serial communication interrupts.	10
4	**Interfacing Applications: -** Interfacing keyboard, LCD, ADC, DAC, Stepper motor & DC motor, 7 segment displays, Elevator.	10
5	**Introduction to ARM Cortex-M processors:** Introduction to ARM cortex-M3, Advantages of the Cortex –M processors, Applications of the ARM cortex-M processors. **Architecture:** Introduction to the architecture, Programmer's model, Behavior of the application program status word. Memory System: Overview of memory system features, Memory map, connecting processor to memory and peripherals **Exception and Interrupts:** Overview of exception and interrupts, Exception types, Overview of interrupt management, Definition of priority, Vector table and vector table relocation, Interrupt inputs and pending behaviors.	12

Text Books:

1. **Kenneth J Ayala :** "*The 8051 Microcontroller Architecture, Programming and Application* " - 2ed Penram International 1996.
2. **Muhammad Ali Mazidi and Janice Gillespie**: "*The 8051 Microcontroller and embedded System"* -Pearson Education 2003.
3. **Joseph You** "*The definitive guide to ARM CORTEX-M3 and to ARM CORTEX-M4 processor*" Third Edition-Elsevier 2014
4. **Shibu K V**, "*Introduction to Embedded Systems*", TMH, 2009

Reference Books:

1. **Andrew N.Sloss**, **Dominic Systems and Chris Wright**- "*ARM system developer Guide Designingand Optimizing System Software"* Elsevier 2004.
2. **Raj Kamal,** "*Embedded Systems Architecture, Programming and Design*" , 2nd Edition, TMH, 2008.

Web Resources:

1. http://infocenter.arm.com/help/topic/com.arm.doc
2. http://www.keil.com

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
CO4	3	3	3	3	3	0	0	0	3	3	0	3	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Signals and Systems	***Course Code: 20EC430***
Credits : 3:1:0	***Total Contact Hours (L:T:P): 39:26:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with different types of signals.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the different types of signals using knowledge of mathematics.
CO2:	Analyze the properties of signals and system.
CO3:	Design solution to the Differential and difference equations of LTI systems.
CO4:	Demonstrate skill sets related to software tools in the analysis and simulation of signals and systems in group.

Unit No.	Course Content	No. of Hours
1	**Basics of Signals and Systems:** Introduction, Definitions and examples of a signal and a system, Classification of signals, Basic operations on signals, Elementary signals, Systems viewed as interconnection of operations, properties of systems. **Matlab Exercise: Representation of signals**	8
2	**Time Domain Representation of LTI systems:** Introduction, Impulse response characterization and convolution sum for the discrete time LTI systems, Properties of convolution sum, Impulse response characterization and convolution integral for continuous time LTI systems, properties of convolution integral, Interconnection of LTI systems, LTI system properties in terms of impulse response, Step response, Differential and Difference equation representation of LTI systems, Characterization of Systems described by differential or difference equations, Block diagram representation. **Matlab Exercise:** **1. Convolution operation on continuous time and discrete time signals.** **2. Evaluate the response of LTI system using convolution.**	8
3	**Fourier analysis of Continuous time signals and LTI systems:** Introduction, Continuous time Fourier transform (CTFT), properties, Magnitude and Phase spectra, Frequency response of continuous time LTI systems, application of Fourier transform, relating FT to FS, Relationship between LT and FT. **Matlab Exercise: To study the frequency domain representation of continuous time signals.**	8
4	**Fourier analysis of discrete time signals and LTI systems:** Discrete time Fourier transform(DTFT), properties and applications of DTFT, Relating the FT to the DTFT, Relating the FT to the DTFS, Sampling and Reconstruction. Finding inverse Fourier Transforms by using Partial fraction expansions, Parsivals Relationships, Time-Bandwidth Product. Applications of Fourier representations to mixed signal classes: Fourier Transform representations of Periodic signals and discrete time signals, Sampling, Fourier series representations of Finite duration non periodic signals. **Matlab Exercise: To study the frequency domain representation of Discrete time signals.**	8
5	**Z- transforms and Applications:**Introduction to z-transform, ROC and its	7

	properties, properties of z- transform, Inverse z-transform, Analysis and characterization of LTI systems using z-transforms, Computational structures for implementing Discrete time LTI systems, Unilateral Z-transforms and their applications for solving difference equations, Relationship between z- , Laplace and DTFTs. **Matlab Exercise:** **1. To find Z-transform of discrete signals and representation of pole-zero plot.** **2. To evaluate response of discrete time LTI systems for different inputs.** **3. Stability analysis of discrete time LTI systems.**	

Text Books:

1. **Simon Haykin and B. V. Veen,** "*Signals and Systems*", Wiley , Second Edition, 2013.
2. **A. V. Oppenheim, A. S. Willsky and S. H. Nawab**, "*Signals and Systems"*, Prentice Hall of India, 2006.
3. **Yang** , "*signals and systems with MATLAB"* ,springer internation edition , 2014

Reference Books:

1. **Michael J Roberts ,** "*Fundamentals of signals and systems*", Tata Mcgraw Hill ,2008.
2. **Ganesh Rao and Satish Tunga**, "*Signals and Systems*", Sanguine Technical Publishers, 2004
3. **Udaya Kumar S** "*Signals and systems*" , 7th Edition , pristine publishing House,2017.

Web Resources:

1. https://nptel.ac.in/courses/1171040741.
2. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/
3. NPTEL lecture Video on Signals and Systems by Prof. S.C.Dutta Roy, http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html
4. NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu,IIT Kharagpur. http://www.nptel.ac.in/courses/108105065/

Program Articulation Matrix

	Program outcomes												Program specific outcomes		
EC430	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	3	3	3	3	3	3	0	0	3	2	0	2	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Communication Systems-II	***Course Code: 20EC440***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: NIL or list of few subjects studied in previous semesters which makes pre requisite for this course.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the importance of digital communication systems
CO2:	Analyze and evaluate the various waveform coding and digital modulation techniques through analytical and simulation methods.
CO3:	Design and demonstrate the performance analysis of optimum receivers for AWGNchannel.
CO4:	Demonstrate the working of digital communication system for the given application.

Unit No.	Course Content	No. of Hours
1	**Introduction**: Digital communication system model, modulation process, analog vs. digital communication; Fundamental limitations of communication systems,.Information content of a discrete memory less source (DMS), Information content of a symbol , Entropy , Information rate, DMC, source coding , entropy coding, error control coding, parity coding, vertical redundancy check, linear block codes, Hamming codes, Cyclic codes and convolution codes.	07
2	**Waveform Coding Techniques:** sampling methods and significance of sampling rate Discretization in time and amplitude. Linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non – uniform quantizer, A law & μ law companding encoding and pulse code modulation, bandwidth of PCM, Differential pulse code modulation, Delta modulation, Idling noise and slope overload, Adaptive delta modulation, adaptive DPCM. Comparison of PCM and DM.	08
3	**Digital Modulation Schemes:** Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM , Minimum shift keying (MSK) , Gaussian minimum shift keying (GMSK) Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).	08
4	**Digital Baseband Transmission:** Line coding and its properties. NRZ & RZ types, signaling format for uni polar, polar, bipolar, AMI & Manchester coding and their power spectra (No derivation), HDB and B&W signaling, ISI, Nyquist criterion for zero ISI & raised cosine spectrum., impulse response and peak pulse signal to noise, correlation detector decision threshold and error probability for binary Unipolar (on – off), signaling.	08
5	**Performance analysis of digital communication:** Optimum detection for binary signals, optimum receiver analysis, Matched filter receiver and its derivation, coherent receivers for carrier modulation, optimum receiver for AWGN channels.	08

Text Books:

1. **Proakis, J.G and Salehi, M,** "*Digital Communications*", 5th Edition , McGraw-Hill, 2008.
2. **B. P. Lathi,**"*Modern digital and analog Communication systems*" - 4th edition, Oxford University Press, 2010,

Reference Books:

1. **Simon Haykins,** "*Communication Systems*"- 5th edition, John Wiley, 2009.
2. **Michael Fitz,** "*Fundamentals of Communication Systems*", TMH, 2008 (for MATLAB exercises and mini projects)
3. **Roden, M.S,** "*Analog and Digital Communication Systems*" - 5th edition, Discovery Press, 2005

Web Resources:

1. https://nptel.ac.in/courses
2. https://nptel.ac.in/courses

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2
CO4	2	2	2	2	2	0	0	0	2	2	0	2	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Engineering Electromagnetics	***Course Code: 20EC450***
Credits: 4	***Total Contact Hours (L:T:P): 52:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Course Outcomes: After completing this course, students should be able to:

CO1:	Interpret various types of fields and charge distributions using vector calculus.
CO2:	Analyze Electrostatic and Magnetostatic models.
CO3:	Design the static and time varying fields to determine its behavior in different mediums.
CO4:	Demonstrate the skill sets using modern tools to solve EM problems.

Unit No.	Course Content	No. of Hours
1	Vector Analysis, Co-ordinate System, Coulomb's Law, Electric field intensity, Electric field due to various charge distribution, Electric flux and flux density, Flux density due to various charge distribution, Gauss Law, Applications of Gauss law, Divergence and Maxwell's Equations.	10
2	Work done & Line Integral Concept, Potential, Potential due to various charge distribution, Potential due to infinite line charge, Conservative field, Potential gradient, dipole, Energy density in ES field, Current and current density, Equation of continuity, Conductor & dielectric, Boundary conditions, Concept of capacitance, Energy stored in capacitance, Poisson's& Laplace Equations, calculating capacitance using Laplace's Equations.	11
3	Magnetic field & its properties, Biot Savart's Law, Computation of H using BSL, Ampere's Circuital Law, Computation of H using ASL, Curl & Stokes Theorem, Magnetic flux & flux density, Scalar & Vector Potentials, Magnetic Forces, Boundary conditions for Magnetic Field.	11
4	Introduction to Time Varying fields, Faraday's equations, Displacement current, Field relations for Time Varying Electric & Magnetic fields, Maxwell's Equations, Relation between field and Circuit Theory.	10
5	Uniform plane waves, General equations, UPW in free space & various media, Poynting Theorem, WavePolarization, Reflection, Refraction, Diffraction of waves, Fundamentals of Antennas and radiating systems.	10

Self Learning Components: Magnetic Materials, Friss Formula and Radar Equations.

Text Books:

1. **William A Hayt, John A Buck, M Jaleel Akhtar**, "*Engineering Electromagnetics*",9th edition, McGrawHill Publication, 2020.
2. **Matthew N.O. Sadiku, S.V. Kulkarni**, "*Principles of Electromagnetics*", 6th edition, Pearson Education, 3rd Impression, 2016.

Reference Books:

1. **David K Cheng** "*Fundamentals of Engineering Electromagnetics*", 2nd edition, Pearson Education Asia, 2019.
2. **Rohit Khurana**, "*Electromagnetic Field Theory*", 2nd edition, Vikas Publication,2016.
3. **J. A. Edminister**, "*Electromagnetics*",4th Edition, McGraw Hill Publication, ,2013.
4. **Karl E. Lonngren, Sava V. Savov**, "*Fundamentals of Electromagnetics with MATLAB*",2nd edition, SciTech Publications, 2007.
5. **John D kraus, Keith R Carver** "*Electromagnetics with applications*",6th Edition,McGrawHill Publications,1998.

E-Resource

1. http://nptel.ac.in/courses/108106073.
2. http://nptel.ac.in/courses/117103065
3. http://ocw.mit.edu/OcwWeb/Electrical-Engineering-and-Computer-Science/6-632Electromagnetic-Wave-TheorySpring2003/CourseHome/Index.htm
4. http://www.plasma.uu.se/CED/Book

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

20EC450	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
CO4	3	3	3	3	3	2	0	0	2	2	0	2	2	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Communication Lab -1	***Course Code: 20EC47L***
Credits: 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Communication Systems -I

Course Outcomes: After completing this course, students should be able to:

CO1:	Analyze various analog modulation and demodulation circuits and sampling theorem
CO2:	Design various analog modulation circuits, frequency synthesizers, pre-emphasis and de-emphasis circuits.
CO3:	Demonstrate the working of FDM, PLL, and Sample and hold circuits and its reconstruction.

EXP No.	Course Content	No. of Hours
1.	Amplitude Modulation and Demodulation	3
2.	DSB SC Modulation and Demodulation	3
3.	SSB SC Modulation andDemodulation	3
4.	Frequency Modulation andDemodulation	3
5.	Pre Emphasis - De EmphasisCircuits	3
6.	Verification of SamplingTheorem	3
7.	PAM Generation and Reconstruction	3
8.	PWM Generation and Reconstruction	3
9.	PPM: Generation	3
10.	Frequency division multiplexing	3

NOTE: A minimum of 10(Ten) experiments must be performed and recorded by the candidate to attain eligibility for University Practical Examination

Text Books:

1. **Wayne Tomasi**– "Electronic Communication Systems" 5th edition, Pearson Education, 2007
2. **B. P. Lathi** "Modern digital and analog Communication systems",4th edition, Oxford University Press, 2010,

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program Outcomes												Program Specific Outcomes		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	3	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO3	3	3	3	0	3	0	0	0	3	3	0	2	0	3	3

Course Title: Microcontrollers and Embedded system Lab	***Course Code: 20EC48L***
Credits: 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Course Outcomes: After completing this course, students should be able to:

CO1:	Design interfacing simple peripheral devices to a Microcontroller.
CO2:	Demonstrate the working of simple peripheral devices using Microcontroller and embedded system.

EXP No.	Course Content	No. of Hours
SET1: Software programs: Problems to be implemented on 8051 microcontroller		
1.	Problems related with data transfer and exchange.	3
2.	Problems related with arithmetic and logical operations.	3
3.	Problems related with programming timers in all modes with and without interrupts.	3
4.	Problems related with programming serial communication with and without interrupts.	3
5.	Program related with handling external interrupts.	3
Set2: Hardware programs: To be implemented on 8051 and ARM CORTEX-M3 (using Embedded C)		
6.	Interface LCD.	3
7.	Interfacing of matrix keypad.	3
8.	Interfacing of ADC and DAC.	3
9.	Interfacing of multi digit 7 segment displays.	3
10.	Interfacing of stepper motor and D C motor.	3

Text Books:

1. **Kenneth J Ayala :** "*The 8051 Microcontroller Architecture, Programming and Application* " - 2ed Penram International 1996.
2. **Muhammad Ali Mazidi and Janice Gillespie** : "*The 8051 Microcontroller and embedded Systems*-" ' -Pearson Education 2003.
3. **Joseph Yiu**'*The definitive guide to ARM CORTEX-M3 and to ARM CORTEX-M4* processor' Third Edition-Elsevier 2014

E -resources

1. **http://infocenter.arm.com/help/topic/com.arm.doc**
2. **http://www.keil.com**

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0
CO2	3	3	3	3	3	2	0	0	2	2	0	2	2	2	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Linear Algebra and Applications	***Course Code:* 20EC510**
Credits : 3	***Total Contact Hours (L:T:P): 39:26:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basic Engineering Mathematics

Course Objectives: To obtain computational proficiency involving procedures in Linear Algebra and also to solve problems that applies Linear Algebra to Chemistry, Economics and Engineering.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe vector spaces and canonical forms with their application.
CO2:	Apply principles of matrix algebra to linear transformations and canonical forms.
CO3:	Analyze and solve the problems on the bases, dimensions and orthogonalization of vectors
CO4:	Demonstrate the skill set to simulate the applications of Linear Algebra as a team member.

Unit No.	Course Content	No. of Hours
1	**Linear equations:** Inverse of a matrix, Gauss Jordan method, LU-factorization. **Vector spaces:** Vector spaces and its properties, subspaces and its properties, Algebra of subspaces, linear combination of vectors, linear independent sets, bases and dimension of a vector space, Rank, change of basis. **SLE**: Applications of vector space.	8:5
2	**Linear Transformations:** Definition, properties and Algebra of Linear Transformation, Linear operator, Range and Nullspace of Linear Transformation, Product of Linear Transformation, polynomials in linear operator Invertible linear transformation, Matrix representation of linear transformation, change of Basis, Trace of a Matrix and Linear Transformation. **SLE**: Correlation, FFT and Convolution using Matrix	8:5
3	Cayley-Hamilton Theorem, Annihilator, Eigenvalues and Eigenvectors of a linear transformation. **InnerProductSpaces:**Innerproducts;innerproductspaces;orthogonalsetsandprojection, orthogonal bases and Gram-Schmidtprocess, Least square problems, applications of innerproductspaces. **SLE**: Fourier Series:Linear Algebra for functions	8:5
4	**Symmetric Matrices and Quadratic forms:** Diagonalization of symmetric matrices, Quadratic forms, Constrained Optimization, Singular Value Decomposition, Application to image processing and statistics. **SLE**: Diagonalization of convolution matrix	8:5
5	**Canonical forms:** similarity of linear transformations, invariant subspaces, invariant direct sum decomposition, normal form, triangular form, nilpotent transformation, Jordan canonical form, Rational canonical form **SLE**: Application of LDA, PCA (dimensionality reduction).	7:6

TEXT BOOKS:

1. **David C Lay,Steven R. Lay, Judi J. McDonald**,*" Linear Algebra and Its Applications*", 5th edition, Pearson education ,2016.
2. **Sudhir Kumar Pundir,** *"Linear Algebra"*, first edition ,CBS Publishers and Distributirs Pvt. Ltd, 2015
3. **Gilbert Strang**, *"Introduction to Linear Algebra"*,5th edition, Wellesley-Cambridge Press,2016.

References:

1. **Kenneth Hoffman and RayKunze,** "*Linear Algebra*",2nd edition, Pearson education,2005.
2. **Seymour lipschutz**, Marc Lipson "*Linear Algebra*", 6th edition, TataMcgraw-Hill ,2018

Web resources:

1. https://onlinecourses.nptel.ac.in/noc18_ma16
2. https://onlinecourses.nptel.ac.in/noc17_ma04/preview

	Program Outcomes												Program Specific Outcomes		
20EC510	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	3	0	3	0	0	0	2	2	0	2	0	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Microwave and Antennas	***Course Code: 20EC520***
Credits: 4	***Total Contact Hours (L:T:P): 52:0:0***
Type of Course: Theory	***Category: Professional Core course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basic Engineering Mathematics, Communication Systems

Course Objectives: The course will enable the students to describe the microwave properties and its transmission media, and microwave devices for several applications, also the student will be able to understand the basics of antenna theory and also select antennas for specific applications

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the principles of microwave frequencies, sources, hazards of microwaves and system modeling using s-parameters.
CO2:	Analyze different terminologies associated with satellite communication, TV, RADAR, their applications.
CO3:	Design different types of antennas for microwave applications.
CO4:	Demonstrate the working microwave antennas using simulation tools.

Unit No.	Course Content	No. of Hours
1	**Introduction to Microwaves:** Introduction, bands, advantages, application and radiation hazards, S-parameters, Microwave filters, Microwave waveguides and components. Avalanche transit time devices – IMPATT diode, TRAPATT diode, Gunn diode, Tunnel diode, Varactor diodes. Microwave linear beam tubes – Klystrons, TWT, Microwave Cross field tubes – Magnetron, parametric amplifiers, Cross field amplifiers. **SLE:** Strip line fabrications	**11**
2	**Satellite Communication:** Basic Principles, Definitions, satellite orbits, ground segments, space segment, Link analysis, Satellite for mobile communication, LEO, MEO, geosynchronous orbit satellites, Link parameters – G/T ratio, EIRP, SNR. **SLE:** losses in strip lines, , Advanced Radar systems, intelligent antennas.	**11**
3	**Radiometry:** Introduction to TV signal standards, scanning principles, composite video, VSB transmission, colour transmission, TV cameras, HDTV principles. **SLE:** Audio and Video compression standards	**10**
4	**Radar Communications:** Nature of Radar and Radar equations, CW and FM radar, MTI radar, Pulse Doppler Radar, Scanning and Tracking Radars, Radar Displays and Radar Beacons. **SLE:** Advanced Radar systems	**10**
5	**Antennas:** Antenna Basics, Antenna Family, Loop, slot, patch, Horn, Helical and Reflector antennas, Antennas for special applications and Antennas for mobile applications **SLE:** Intelligent antennas	**10**

Text Books:

1. **Annapoorna Das: "***Microwave engineering*", 2nd edition, McGraw-Hill, 2017.
2. **Samuel. Y. Liao: "***Microwave Devices and Circuits*", 3rd edition, Prentice Hall, 2004.
3. **M I Skolnik: "***Introduction to Radar*", 4th edition, McGraw-Hill, , 2004

Reference Books:

1. **Kennedy: "***Communication Systems*", 5th edition, McGraw-Hill, 2011
2. **D Kraus:** "*Antennas for all applications*", 2nd edition, McGraw-Hill, 2008.

Web Resources:

1. Microwave Communication basics by Morgan Kurk, www.commscope.com
2. Video lecture- Microwaves, nptel.ac.in-IIT, Bombay

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC520	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	3	0	3	0	0	0	2	0	3	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Control Systems	*Course Code: 20EC530*
Credits : 4	*Total Contact Hours (L:T:P): 39:26:0*
Type of Course: Theory	*Category: Professional Core Course*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Signals and Systems, Engineering Mathematics

Course Objective: To develop theoretical concepts and analytical skills for students in modeling and control of different engineering systems. To inculcate modern software skills for modeling, analysis and design using transfer function and state approach from both time domain and frequency domain perspective.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the physical systems as mathematical model.
CO2:	Analyze various properties of the control systems in time domain and frequency domain using appropriate tools.
CO3:	Design and test the controllers for transfer function and state-space models.
CO4:	Evaluate the state-space models of systems using appropriate tools.
CO5:	Demonstrate the performance of controllers using modern tools.

Unit No.	Course Content	No. of Hours
1	**System Modeling:** Review of Signals, Systems, Fourier and Laplace transform, Concept of feedback control, transfer function and state-space modeling of mechanical, electrical and electromechanical systems, Block diagram representation and its algebra, Signal flow graphs and Mason's gain formula. **SLE:** Transfer function and State space model of Boeing aircraft, Satellite, Power systems	8:5
2	**Time domain analysis**: Effect of pole-zero location and addition, step response and impulse response of the standard first and second order systems, Stability w.r.t. transfer function and state-space (external and internal stability), Routh-Hurwitz method, Steady state error analysis of Type-0,1,2 systems. **SLE:** Lyapunov's stability theorems	8:5
3	**Controller Design for TF:**Design of classical PI, PD and PID controllers, Root-locus of a basic feedback system and rules for sketching RL, Design of Phase-lead controller using Root-Locus. **SLE:**PID control design using MATLAB,	8:5
4	**Controller Design for SS:**State-space design and its advantages, solution of state-equations, Canonical models, Controllability and Observability Properties, full-state feedback control,selection of pole locations for good design, estimator/observer design, combined control law and estimator. **SLE:** Linear Quadratic Regulator (LQR)	8:5
5	**Design in Frequency Domain:** Frequency response of LTI system and Bode plots, Nyquist stability criterion, stability margins, closed-loop frequency response, design of Phase lead compensator using Bode plots. **SLE:** Design of Phase-lead and lag compensator using MATLAB	7:6

Text Books:

1. **G. F. Franklin., G. D. Powell., A. E. Naeini**, *"Feedback Control of Dynamic Systems"*, Pearson Education, 5th Edition, 2002.

2. **M. Gopal**, "*Control Systems: Principles and Design"*, Tata Mc Graw Hill, 2012.

Reference Books:

1. **K. Ogata**, "*Modern Control Engineering"*, 4th Edition, Pearson Education, 2006.
2. **S. K. Bhattacharya**, "*Control Systems Engineering"*, Pearson Education, 2005.

Web Resources:

1. Dr. M. Gopal https://www.youtube.com/watch?v=vVFDm__CdQw
2. https://www.youtube.com/channel/UCq0imsn84ShAe9PBOFnoIrg

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC530	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	3	3	0
CO4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
CO5	3	3	3	3	3	0	0	3	3	3	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Digital Signal Processing	***Course Code: 20EC540***
Credits : 4	***Total Contact Hours (L:T:P): 39:26:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Signals and Systems

Course Objective: To make students learn digital signal processing techniques, DFT and FFT techniques. The course will enable students to analyze, design and realize digital filters.

Course Outcomes: After completing this course, students should be able to:

CO1:	Comprehend the representation of discrete-time signals in frequency domain and its properties, using discrete Fourier transform.
CO2:	Apply FFT algorithms to compute DFT
CO3:	Analyze, design and realize digital filters for the given specifications
CO4:	Implement applications of Digital Signal Processing algorithms using computer aided tool

Unit No.	Course Content	No. of Hours
1	**Discrete Fourier Transform:** Introduction to DFT, Frequency domain sampling and reconstruction of discrete time signals, DFT as a linear transformation, its relationship with other transforms. Direct computation of DFT, Properties of DFT. Use of DFT in linear filtering **SLE:** Sampling theorem	8:5
2	**FFT Algorithms:** DIT and DIF algorithms for computing DFT and IDFT. **SLE:** Goertzel algorithm, Chirp-Z Transform	8:5
3	**IIR Filters:** Introduction to IIR filters, characteristics of commonly used analog filters, frequency transformations, design of IIR filters from analog filters using IIT and BLT techniques. **SLE:** Round-off and finite word length effects in digital filters	8:5
4	**FIR Filters:** Introduction to FIR filters, Design of FIR filters using windowing and frequency sampling techniques. Quantization of filter coefficients, **SLE**: Hilbert transform	8:5
5	**Digital Filter Realization**: Direct form-I, direct form-II, Transposed, cascade, parallel and lattice methods of realizations of FIR and IIR filters. Introduction to multirate signal processing and Digital signal processors **SLE:** Applications of signal processing	7:6

Reference Books:

1. **Proakis and Manolakis**, "*Digital signal processing – Principles, Algorithms and applications*", 4th Edition,Pearson Education, 2007.
2. **Oppenheim and Schaffer**, "*Discrete time signal processing*", PHI, 2003.
3. **S.K. Mitra** , "*Digital signal Processing*", TMH, 2004.

Web Resources:

1. IEEE Transactions on Signal Processing.
2. https://nptel.ac.in/courses/117102060

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC540	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO2	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO3	**0**	**2**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**0**
CO4	**0**	**3**	**3**	**3**	**3**	**0**	**0**	**0**	**3**	**2**	**2**	**2**	**3**	**3**	**2**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Digital Signal Processing Lab	***Course Code: 20EC57L***
Credits : 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Signals and Systems, Digital Signal Processing

Course Objective: To make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and the importance of Signal Processors.

Course Outcomes: After completing this course, students should be able to:

CO1:	Analyze and verify signal processing concepts and algorithms
CO2:	Design and demonstrate signal processing algorithms using simulation tool and/or Hardware platform

Expt No.	Experiment Name	No. of Hours
1	Explore Digital Signal Processing Virtual Laboratory of Department of Electronics and Electrical Communication Engineering Indian Institute of Technology, Kharagpur http://www.digital.iitkgp.ernet.in/dsp/expts/index.php	3
2	a) Write a MATLAB code to illustrate the Nyquist sampling theorem. The program should illustrate the effects the sampling the signal at • Exactly the folding frequency • Frequency less than the folding frequency • Frequency greater than the folding frequency Plot the magnitude spectrum for all the above said cases b) Write a MATLAB code to compute the DTFT and DFT of a sequence x (n). Also plot the magnitude spectrum of both DTFT and DFT and provide the inference on the basis of results obtained. Further compute the IDTFT and IDFT.	3
3	Write a MATLAB code to verify the following properties of DFT a) Linearity b) Periodicity c) Circular shift and Circular symmetry of a sequence d) Symmetry property e) Circular convolution and multiplication of two sequences f) Time reversal of a sequence g) Circular time shift and Circular frequency shift of a sequence h) Parseval's theorem	3
4	Write a MATLAB code to compute the DFT of a sequence x (n) using DIT and DIF algorithm. Also indicate the speed improvement factor in calculating the DFT of a sequence using direct computation and FFT algorithm (Use the same sequence as used in Program2).Further compute the IDFT using IDIT and IDIF algorithm.	3
5	Write a MATLAB code to verify the Low pass and High Pass FIR linear phase filter design using Hamming and Hanning windows (with inbuilt and without using inbuilt commands). Plot the magnitude and phase response. Also, Provide the inference on the basis of results obtained for these to specifications. (To design should be verified by convolving the input signal with the designed filter coefficients)	3

6	Write a MATLAB code to verify the Band pass and Band reject FIR linear phase filter design using Hamming and Hanning windows (with inbuilt and without using inbuilt commands). Plot the magnitude and phase response. Also, Provide the inference on the basis of results obtained for the set of specifications.	3
7	Write a MATLAB code to implement the Low pass Chebyshev (Type1) IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.	3
8	Write a MATLAB code to verify the Low pass Butterworth IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.	3
9	Write a MATLAB code to illustrate the effect of Decimation and Interpolation by an integer factor. Plot the magnitude spectrum. Design the necessary filter to overcome aliasing and image frequencies after decimating and inter-polating the signal respectively.	3
10	Write a MATLAB code to illustrate the effect of sampling rate conversion by a non-integer factor. Plot the magnitude spectrum. Design the necessary filter to overcome aliasing and image frequencies.	3
11	Read the data file named ecg2x60.datfrom http://people.ucalgary.ca/~ranga/enel563/SIGNAL_DATA_FILES/ That is corrupted with the 60Hz noise component. Write a MATLAB code to remove this 60Hz noise component from the signal using Notch filter and LMS adaptive filter. Plot the magnitude spectrum of the signal filtered using both Notch filter and LMS adaptive filter and provide the inference on the basis of results obtained.	3
HardwareExperimentUsingTMS320C6713DSPKit		
12	a. Write a C code to obtain the impulse response of a given system and implement the same on TMS320C6713 DSK-kit. b. Write a C code to compute the linear and circular convolution and implement the same on TMS320C6713 DSK-kit.	3
13	a. Write a C code to compute the cross-correlation and auto-correlation and implement the same on TMS320C6713 DSK-kit. b. Write a C code to compute N-point DFT and IDFT of a sequence and implement the same on TMS320C6713 DSK-kit.	3

Reference Books:

1. **Sanjit K Mitra,**"*Digital Signal Processing Laboratory Using MATLAB*", McGraw Hill International Edition, 2002.
2. **Vinay K Ingle and John G Proakis,**"Digital *Signal Processing Laboratory Using MATLAB*", 3rd Edition, Cengage Learning, 2010.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**2**	**2**	**2**	**0**	**0**	**0**	**2**	**3**	**0**	**2**	**3**	**3**	**0**
CO2	**3**	**3**	**3**	**2**	**3**	**0**	**0**	**0**	**2**	**3**	**0**	**2**	**3**	**3**	**0**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Communication Lab II	***Course Code: 20EC58L***
Credits: 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Basic Knowledge of Digital Communication.

Course Objectives: This course gives students deep knowledge in digital communication systems at the practical level. This lab focuses the fundamental concepts on TDM, Pulse modulations, digital modulation and demodulation techniques.

Course Outcomes: After completing this course, students should be able to:

CO1:	Analyze and design various digital modulation and demodulation circuits and analog to digital and DAC circuits and simulate using open source simulation tools.
CO2:	Demonstrate the working digital communication system and microwave experiments using microwave bench setup

Expt No.	Experiment Name	No. of Hours
1	Design an Analog to digital converter using Flash type ADC/DAC using weighted resisters	3
2	Design an ASK modulator and Demodulator using discrete components and Kit	3
3	Design an FSK modulator and Demodulator using discrete components and Kit	3
4	Design an PSK modulator and demodulator using discrete components and Kit	3
5	Design a Time division multiplexing and de-multiplexing	3
6	Design a Pulse code modulation and implement using Matlab simulator tool.	3
7	Design a Delta modulation and demodulation and implement using Matlab simulator tool.	3
8	Design an Adaptive delta modulation and demodulation and implement using Matlab simulator	3
9	Implementation of digital and analog modulation using OFC Kit	3
10	Design and demonstrate the TDM and de Multiplexing circuits	3
11	Demonstrate the working of FDM and de Multiplexing using digital trained kits.	3
12	Simulate and demonstrate the working of PCM and Delta Modulation using Matlab simulation tool.	3
13	Simulates the working principle of shannon fano and hufman coding techniques using Matlab coding simulation tool.	3

Text Books:

1. **Wayne Tomasi**, *"Advanced Electronic Communication Systems"*, 6th Edition, Pearson Education, 2009.
2. **Simon Haykin**, *"Communication Systems"*, 4th Edition, John Wiley & Sons, 2004

Reference Books:

1. **B. P.Lathi**, *"Modern Analog and Digital Communication Systems"*, 3rd Edition, Oxford University Press, 2007
2. **Martin S.Roden**, "Analog and Digital Communication System", 3rd Edition, Prentice Hall of India, 2002.

Web Resources:

1. https://nptel.ac.in/courses/117101051
2. https://www.youtube.com/watch?v=pNkTWgtUjDU

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
CO2	**3**	**0**	3	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**2**	**3**	**0**	**3**	**3**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Essence of Indian Traditional Knowledge	***Course Code: 20HU511 / 20HU512***
Credits: 0	***Total Contact Hours (L:T:P): 26:0:0***
Type of Course: Theory	***Category: Humanities***
CIE Marks: 50	***SEE Marks: -***

Pre-requisite: Basic Knowledge of Digital Communication.

Course objectives: The course aims at imparting basic principles of thought process, reasoning and inferencing and also to focus on introduction to Indian Knowledge Systems, Indian perspective of modern scientific world-view, and basic principles of Yoga and holistic health care system.

Course Outcome:
CO1: Ability to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.

CO-PO Mapping (Articulation Matrix):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	0	1	1	0	2	0	0	0	1

Course Contents:
- Basic structure of Indian Knowledge System: Ashtadhashavidya – 4 Veda, 4 Upaveda (Ayurveda, Dhanurveda, Gandarvaveda, Sthapathya Adi) 6 Vedanga (Shiksha, Kalp, Nirukth, Vyakaran, Jyothishya, Chand) 4 Upadg (Dharmashashtra, Mimamsa, Purana, Tharkashashtra).
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References:

1. V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan.
3. Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan.
4. Fritzof Capra, Tao of Physics.
5. Fritzof Capra, The Wave of life.
6. VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Arnakulam.
7. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
8. GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakashan, Delhi 2016.
9. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016.
10. P B Sharma (English translation), Shodashang Hridayan.

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

Course Title: Solid State Electronics	***Course Code: 20EC551***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basic Knowledge of Electronics

Course objectives: The course is an introduction to semiconductor fundamentals and applications to the electronic devices. Course creates the background in the physics of the compound semiconductor-based electronic devices and also prepare students to advanced courses in solid state and advanced electronics.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the crystal structures of elements used for fabrication of semiconductor devices.
CO2:	Analyze energy band structure of semiconductor devices.
CO3:	Design and develop physical models for semiconductor devices.
CO4:	Demonstrate the characteristics of various semiconductor devices such as Varactor diode, Zener diode, Schottky diode, BJT, MOSFET.

Unit No.	Course Content	No. of Hours
1	**Crystal Properties and Growth of Semiconductors:** Semiconductor materials- Periodic Structures- Crystal Lattices- Cubic lattices – Planes and Directions-The Diamond lattice- Bulk Crystal Growth-Starting Materials-Growth of Single Crystal lngots-Wafers-Doping- Epitaxial Growth –Lattice Matching in Epitaxial Growth –Vapour –Phase Epitaxy-Atoms and Electrons-Introduction to Physical Models-Experimental Observations-The Photoelectric Effect-Atomic spectra-The Bohr model-Quantum Mechanics –Probability and the Uncertainty Principle-The Schrodinger Wave Equation –Potential Well Equation –Potential well Problem-Tunnelling.	8
2	**Energy Bands and Charge Carriers in Semiconductors:** Bonding Forces and Energy bands in Solids-Bonding Forces in Solids-Energy Bands-Metals, Semiconductors, and Insulators – Direct and Indirect Semiconductors –Variation of Energy Bands with Alloy Composition-Charge Carriers in Semiconductors-Electrons and Holes-Effective Mass-Intrinsic Material-Extrinsic Material – Electrons and Holes in Quantum Wells-Carrier Concentrations-The Fermi Level-Electron and Hole Concentrations at Equilibrium-Temperature Dependence of Carrier Concentrations. Drift and diffusion current.	8
3	**Junctions:** Fabrication of P-N Junctions-Thermal Oxidation-Diffusion –Rapid Thermal Processing-Ion Implantation-Chemical Vapour Deposition Photolithography-Etching –Metallization-Equilibrium Conditions-The Contact Potential-Equilibrium Fermi Levels –Space Charge at a Junction-Forward –and Reverse –Biased Junctions; -Steady state conditions-Qualitative Description of current flow at a junction-Carrier Injection-Reverse Bias-Reverse –Bias Breakdown-Zener Breakdown –Avalanche Breakdown-Rectifiers-The Breakdown Diode-Transient and AC Conditions –Time variation of stored charge-Reverse Recovery Transient –Switching Diodes –Capacitance of P-N Junctions.	8
4	**The Metal–Semiconductor-FET:** The GaAS MESFET-The High	8

	Electron Mobility Transistor –Short channel Effects-The Metal Insulator Semiconductor FET-Basic Operation and Fabrication –THE ideal MOS Capacitor-Effects of Real Surfaces-Threshold Voltage –MOS capacitance Measurements- current –Voltage Characteristics of MOS Gate Oxides -The MOS Field –Effect Transistor –Output characteristics-Transfer characteristics- Mobility Models-Short channel MOSFET I-V characteristics –Control of Threshold Voltage –Substrate Bias Effects-Sub threshold characteristics –Equivalent Circuit for the MOSFET.	
5	**Optoelectronic Devices**: Photodiodes-Current and Voltage in illuminated Junction-Solar Cells-Photo detectors-Noise and Bandwidth of Photo detectors-Light-Emitting Diodes-Light Emitting Materials-Fiber Optic Communications Multilayer Heterojunctions for LEDs-Lasers-Semiconductor lasers-Population Inversion at a Junction Emission Spectra for p-n junction-The Basic Semiconductor lasers-Materials for Semiconductor lasers-Integrated Circuits –Background –Advantages of Integration –Types of Integrated circuits-Monolithic and Hybrid Circuits-Evolution of Integrated Circuits-Monolithic Device Elements CMOS Process Integration –Silicon –on – Insulator (SOI)-Integration of other Circuit Elements –Charge Transfer Devices –Dynamic Effects in MOS capacitors.	7

Text Books:

1. **Ben.G.Streetman & Sanjan Banerjee, "***Solid State Electronic Devices"*,(5th Edition) PHI Private Ltd, 2003
2. **Chih Tang sah,** "*Fundamentals of Solid State of Electronics "*, Volume 1, World Scientific, 1996.

Reference Books:

1. **Yannis Tsividis,** "*Operation & Mode line of The MOS Transistor"*, (2nd Edition) Oxford University Press, 1999.
2. **Nandita Das Gupta & Aamitava Das Gupta**, "*Semiconductor Devices Modelling a Technology"*, PHI, 2004.

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Web Resources:

1. **https://www.youtube.com/watch?v=Kp-jS6NHsB8&list=PLF178600D851B098F**
2. **https://www.youtube.com/watch?v=PimBOLBTE5U&list=PLqYqvTonHe89ORH_LjZnwqJEstaaJ-vuF**

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC551	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Neural Networks and Machine Learning	***Course Code:*20EC552**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Students should be familiar with basic mathematics.

Course Objectives: To make students learn the concepts of neural network architecture and algorithms. The course will enable the students to learn supervised and unsupervised machine learning algorithms.

Course Outcomes: After completing this course, students should be able to:

CO1:	Comprehend the theoretical foundation of neural networks and machine learning.
CO2:	Analyze neural network architecture and algorithm.
CO3:	Analyze supervised and unsupervised machine learning algorithm.
CO4:	Demonstrate the real-world applications using neural networks and Machine Learning.

Unit No.	Course Content	No. of Hours
1	**Linear Regression and Classification:** Problem Formulation, Parameter Estimation: Maximum Likelihood Estimation, Overfitting in Linear Regression, Maximum A Posteriori Estimation, MAP Estimation as Regularization, Bayesian Linear Regression, Confusion matrix, Classification matrix.	8
2	**Dimensionality Reduction with Principal Component Analysis:** Problem Setting, Maximum variance perspective: Direction with maximal variance, M-dimensional subspace with Maximal variance, Projection Perspective: Setting and objective, Finding Optimal Coordinates, Finding the Basis of the Principal Subspace, Eigenvector Computation, and Low –Rank Approximations, PCA in High Dimensions, Optimization, Optimization techniques, Contractual, nonstructural.	8
3	**Model Building Through Regression:** What is a Neural Network?, Network Architectures, learning process, Linear Regression Model: Preliminary Considerations, Maximum a Posteriori Estimation the parameter Vector, Relationship Between Regularized Least Squares Estimation and MAP Estimation, The Minimum Description-Length Principle, Multilayer Perceptrons: Batch Learning and On-Line Learning, The Back-Propagation Algorithm, Back Propagation and differentiations, Convolutional Networks, Small-scale Versus Large-Scale Learning Process.	8
4	**Kernel Methods and Radial-Basis Function Networks:** Cover's Theorem on the separability of patterns, The Interpolation Problem, Radial-Basis-Function Networks, K-means Clustering, Recursive Least-squares estimation of the Weight Vector, Hybrid Learning Procedure for RBF Networks, Interpretations of the Gaussian Hidden Units, Kernel Regression and Its Relation to RBF Networks, The Support Vector Machine Viewed as a Kernel Machine, Design of Support Vector Machines.	8
5	**Regularization Theory:**Regularization Networks, Semisupervised Learning, Manifold Regularized: Preliminary Considerations, Differentiable Manifolds, Spectral Graph Theory, Laplacian Regularized Least mean squares algorithm	7

SLE	Computer Experiments - Linear Prediction, Pattern Classification, Pattern Classification using supervising, Semisupervised Learning.

Text Books:

1. **Cheistopher M. Bishop** "*Pattern Recognition and Machine Learning*" Springer. 2006.
2. **Simon Haykin** "*Neural networks and Learning Machines*" Pearson, 3rd Edition. 2016.

Reference Books:

1. **Tomm. Mitchell** "*Machine Learning*" McGraw Hill Education, 22nd reprint 2018.
2. **Bekkerman, Ron, Mikhail Bilenko, and John Langford, eds**. "*Scaling up machine learning: Parallel and distributed approaches"* Cambridge University Press, 2011.
3. **Frank Pane**, "*Hands-On Data Science and Python Machine Learning*", Packt Publishers 2017.

Web Resources:

1. https://nptel.ac.in/courses/117105084
2. https://onlinecourses.nptel.ac.in/noc22_cs29/preview
3. https://nptel.ac.in/courses/106105152

Mapping - Course Outcomes with Program outcomes & Program-Specific outcomes

	Program outcomes												Program specific outcomes		
20EC552	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													2	2
CO2		3		2									2	3	3
CO3			3	2									2	3	3
CO4	3	3	3	3	3	2		3	3	3	2	3	3	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Principles of wireless communication systems	***Course Code: 20EC553***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: To expose the students to understand mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the cellular concepts, frequency reuse, fading, equalization, GSM , CDMA
CO2:	Analyze the basic knowledge for propagation models to calculate link budget using path loss model.
CO3:	Demonstrate different multiple access techniques in mobile communication for real time applications through simulation

Unit No.	Course Content	No. of Hours
1	**Introduction To Mobile Communication**: Evolution of Mobile Radio Communication, Examples of Wireless Communication Systems. Paging system, Cordless telephones systems, Cellular telephone Systems, Cellular concept: Frequency reuse, Channel Assignment strategies, Hand off strategies. Interference and System capacity, Improving coverage and capacity in cellular systems.	8
2	**Mobile Radio Propagation: Large Scale Fading**: Free space propagation model, Three basic propagation mechanisms, Reflection, Ground Reflection(Two-Ray)Model, Diffraction, Scattering, Practical link budget using path loss models. **Small Scale Fading** : Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, Fading effects due to multipath time delay Spread and Doppler spread.	8
3	**Equalization**: Fundamentals of Equalizers, Linear equalizers, Non-linear equalizers, Decision feedback equalizers, MLSE. **Diversity Techniques**: Space diversity: MRC, EGC Selection diversity, Polarization diversity, Frequency diversity, Time diversity	8
4	**Global System For Mobile (GSM)**: Historical overview, System overview, The air interface, Logical and physical channels, Synchronization, Coding, Equalizer, Circuit-switched data transmission, Establishing a connection and handover, Services and billing.	8
5	**CDMA**: Historical overview, System overview, Air interface, Coding, Spreading and Modulation, Logical and Physical channels, Handover.	7

Text Books:

1. **Theodore S. Rappaport**, *"Wireless Communications Principles and Practice*", 2nd Edition, Pearson Education, 2014.

2. **Andreas F. Molisch**, "*Wireless Communications*", 3nd Edition, John Wiley, 2020.

Reference Books:

1. **Kamilo Feher**, *"Wireless Digital Communications"*, 3rd Edition, PHI, 2015
2. **W.C.Y. Lee**, *"Mobile Cellular Communications"*, 2rd Edition, MC Graw Hill, 2006.
3. **Yi-Bing Lin**, *"Wireless and Mobile Network Architectures"*, 2nd Edition, Wiley, 2008.

Web Resources: http://nptel.ac.in/courses/

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC553	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	2	0	0	3	3	0	0	0	3	0	0	2	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Smart Electronic Materials	***Course Code: 20EC554***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of electronics and fundamentals of material physics.

Course Objectives: To acquaint with various kinds of smart materials for device application, to have the knowledge about the different types of structure of the materials which affect their properties, To use the nanotechnology in electronics.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the functions of smart materials.
CO2:	Apply the various synthesis and fabrication techniques to develop smart electronic materials.
CO3:	Analyze the properties of smart materials with the applications.
CO4:	Demonstrate the skill sets to simulate the applications of smart electronic materials.

Unit No.	Course Content	No. of Hours
1	**Introduction**: Material science and engineering, crystal geometry and structure determination, fundamental concepts of molecular nanotechnology, current research and approaches towards nanomaterials, biomaterials, speculative, tools and techniques, applications, implications. Introduction to quantum mechanics.	8
2	**Fullerence:** Prediction and discovery, variations, buckyball ,properties of Fullerence. **Carbon Nanotubes:** Types of carbon nanotubes and related structures, properties and applications, Boron Nitride nanotubes, selective chemistry of single walled nanotubes. **Nanowire:** Synthesis of nanowires, physics, molecular wires and fabrication, solar nanowires.	8
3	**Self-Assembly:** Mechanism and examples of self-assembly. **Nanophotonics:**Components of nanophotonic system. **Nanomaterial Synthesis and Application:** Introduction, uniformity, properties, nanoscale and nanoshell particles, nanotoxicity.	8
4	**Properties of Smart materials**: Electrical properties, optical properties, the colored glasses. **Other nanomaterials:** Importance of nanomaterials, nano-Optics, nano-Magnetics, nano-Electronics materials, shape memory alloys etc.	8
5	**Nanocomposites and their applications:** Nanocomposites clay based, nanoceramic composites, metal and oxide nanocomposites, processing and characterization, nanotechnology in electronics and allied industries.	7

SLE: Nanotechnology in Auto Industry, Nanotechnology in Energy, Nanomaterials for Energy storage and Conversion.

Text Books:

1. **WM Breck,** "*Nanotechnology, volume1"*,1st edition, CBS publishers & Distributors Pvt Ltd, 2016.
2. **WM Breck,** "*Nanotechnology, volume 2"*,1st edition, CBS publishers & Distributors Pvt Ltd, 2016.

Reference Books:

1. **V. Raghavan**, *"Material Science and Engineering"*,5th edition, PHI Learning Private Limited, 2009.
2. **Sulabha K. Kulkarni**, *"Nanotechnology, Principles and Practices"*,2nd edition, Capital Publishing Company, 2011.

Web Resources:

1. https://nptel.ac.in/courses/112104173
2. DOI:10.1016/B978-0-12-815732-9.00066-8

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC554	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	3	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	0	2	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	0	3	0	0	2	2	0	2	0	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Data Structures and Algorithms	***Course Code: 20EC555***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of C programming.

Course Objectives: To make students to gain the knowledge of basic data structures and their implementations in context of writing efficient programs and developing the skills to apply appropriate data structures in problem solving.

Course Outcomes: After completing this course, students should be able to:

.

CO1:	Explain programming skills through Object Oriented Programming(OOP) and accessing different types of data structures
CO2:	Apply programming skills through OOPs and efficient storage mechanisms of data for an easy access
CO3:	To design, evaluate and implementation of various basic and advanced data structures for skill enhancement in problem solving and develop applications.
CO4:	Develop and demonstrate innovative programming solutions/ Refine available solutions by improving the existing code and select algorithm design approaches in a problem specific manner.

Unit No.	Course Content	No. of Hours
1	**Object Oriented Programming (OOP) using C++:** Introduction to C++, declaration of Variables, Dynamic Initialization of Variables, Reference Variables, Operators in C++ other than C, Functions in C++, Basic Concepts of OOP, advantages, Classes and Objects, Data abstraction and encapsulation, Polymorphism, Inheritance, Constructors and Destructors, Virtual Functions.	8
2	**Data Structures:**Space and time complexity, Introduction Data Structures, Types of Data Structures. Introduction to Arrays, Matrices, Stacks and Queues, Stacks Operation, abstract data types(ADT), implementation, applications of stacks. Queues, ADT, implementation of queues and its applications. Introduction to circular queues, double ended queues.	8
3	**Linked Lists:** Introduction, Linked Lists, Abstract data type, sequential and linked representations, comparison of insertion, deletion and search operations for linked lists, circular lists, skip lists and hashing: Search efficiency in lists and skip lists, hashing as a search structure, hash table. double hashing.	8
4	**Trees:** Binary trees and their properties, terminology, types and representation of trees, tree traversal methods and algorithms, Search Trees: Binary search trees, search efficiency, insertion and deletion operations, AVL trees, searching, insertion and deletions in AVL trees, applications of trees	8
5	**Graphs:** Definition, terminology, directed and undirected graphs, properties, connectivity in graphs, graph traversal – breadth first and depth first, applications of graphs. Algorithm Design Techniques: Dijkstra's Algorithm, Greedy algorithm (Minimum Spanning Tree), back tracking.	7

SLE: Linked lists through simulated pointers, leftist trees, tournament trees, use of winner trees in merge sort as an external sorting algorithm, sorting algorithms, bin packing, comparison of different trees with AVL trees.

Text Books:

1. **SartaSahni, S**, *"Data Structures, Algorithms, and Applications in C++"*,3rd Edition,McGraw-Hill Education, 2001
2. **E. Balaguruswamy**, *"Object Oriented Programming with C++"*, Sixth Edition, McGraw Hill Education, 2014.
3. **Vaidyanathan,***"Data Structures, Algorithms and Applications in C++"*,1st Edition, CBS Publications, 2013.

Reference Books:

1. **Michael T. Goodrich,** "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2009
2. **Drozdek, A,** " Data Structures and Algorithms in C ++", Vikas Publishing House, Edition 2002

Web Resources:

1. https://nptel.ac.in/courses/(106102064 or 106106127 or 106103069)
2. http://www.nptelvideos.com/computer_science/datastructures_algorithms.php
3. https://onlinecourses.swayam2.ac.in/cec19_cs04/preview
4. https://www.classcentral.com/course/swayam-programming-data-structures-and-algorithms-2778

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC555	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	3	3	3	0	0	0	3	3	0	2	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

VI Semester

Course Title: **Information Theory and Coding**	***Course Code: 20EC610***
Credits : 4	***Total Contact Hours: 52:0:0***
Type of Course: Lecture	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basic knowledge of Digital Communication

Course Objective: Students will get familiar to information theory, Probabilistic (stochastic) systems, Reasoning under uncertainty, State and discuss coding theorems.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the significance of quantitative measure of information in the communications
CO2:	Implement the various types of source coding algorithms and analyze their performance
CO3:	Apply the different methods for error detection and correction in a communication system.
CO4	Perform mathematical analysis of problems in Information Theory and Coding, Implementation and verification using simulation tool.

Unit No.	Course Content	No. of Hours
1	Information theory: Concept of amount of information, information units Entropy: marginal, conditional, joint and relative entropies, relation among entropies Mutual information, information rate, channel capacity, redundancy and efficiency of channels Discrete channels – Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Noise-Free Channel, Channel with independent I/O, Cascaded channels, repetition of symbols, Binary asymmetric channel, Shannon theorem.	**11**
2	Source coding – Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy, Source coding theorem. Construction of basic source codes – Shannon Fano coding, Shannon Fano Elias coding, Huffman coding, Minimum variance Huffman coding, Adaptive Huffman coding, Arithmetic coding, Channel coding theorem for DMC. SLE- Dictionary coding – LZ77, LZ78, LZW, ZIP coding Channel coding,	**11**
3	Codes for error detection and correction – Parity check coding, Linear block codes, Error detecting and correcting capabilities, Generator and Parity check matrices, Standard array and Syndrome decoding, Hamming codes	**10**
4	Cyclic codes – Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction.	**10**
5	Convolutional codes – Encoding and State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes -Viterbi algorithm, Sequential decoding -Stack algorithm. SLE- Interleaving techniques – Block and convolutional interleaving, Coding and interleaving applied to CD digital audio system	**10**

Text Books:

1. **T. M. Cover, J. A. Thomas,** "*Elements of Information Theory*", second edition, Wiley, 2005.
2. **R. Togneri, C.J.S deSilva,** "*Fundamentals of Information Theory and Coding Design*", first edition, Taylor and Francis, 2003.
3. **P.S Satynarayana, "***Information Theory and Coding*",second edition,Medtech, 2020.

Reference Books:

1. **R. J. McEliece,** "*The Theory of Information and Coding*",2nd Edition, Cambridge Uinversity Press, 2004.
2. **R. Bose,** "*Information Theory Coding and Cryptography*", second edition, Tata McGraw Hill, 2008.

Web Resources:

1. https://nptel.ac.in/courses/117101053
2. https://nptel.ac.in/courses/108102117

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC610	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
CO2	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**
CO3	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**3**
CO4	**0**	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**3**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Computer Networks	***Course Code: 20EC620***
Credits: 4	***Total Contact Hours (L:T:P): 52:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic components of computer.

Course Objectives: This course will enable students to understand the layering architecture of OSI reference model and TCP/IP protocol suite. Understand the different networking architectures and various routing techniques and the transport layer services.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the layering architecture of computer networks and distinguish between the OSI reference model and TCP/IP protocol suite.
CO2:	Identify the protocols and services of Data link layer.
CO3:	Apply the IP address assignment scheme and standards associated with each network.
CO4:	Analyze the design of routing strategies and operations of end to end delivery mechanisms and their functionalities

Unit No.	Course Content	No. of Hours
1	**Introduction Data Communications:** Components, Representations, Data Flow, Networks: Physical Structures, Network Types: LAN, WAN, Switching, Internet. Network Models: Protocol Layering: Scenarios, Principles, Logical Connections, TCP/IP Protocol Suite: Layered Architecture, Layers in TCP/IP suite, Description of layers, Encapsulation and Decapsulation, Addressing, Multiplexing and De-multiplexing, The OSI Model: OSI Versus TCP/IP. Data-Link Layer: Introduction: Nodes and Links, Services, Categories of link, Sublayers, Link Layer addressing: Types of addresses, ARP. Data Link Control (DLC) services: Framing, Flow and Error Control, Data Link Layer Protocols: Simple Protocol, Stop and Wait protocol, Stop and wait ARQ, GBN ARQ, SR ARQ protocols, Piggybacking.	11
2	**Media Access Control:** Random Access: ALOHA, CSMA, CSMA/CD, CSMA/CA. Controlled Access: Reservation, Polling, Token Passing.Wired LANs: Ethernet: Ethernet Protocol: IEEE802, Ethernet Evolution, Standard Ethernet: Characteristics, Addressing, Access Method, Efficiency, Implementation, Fast Ethernet: Access Method, Physical Layer, Gigabit Ethernet: MAC Sublayer, Physical Layer, 10 Gigabit Ethernet.	11
3	**Wireless LANs:** Introduction: Architectural Comparison, Characteristics, IEEE 802.11: Architecture, MAC Sublayer, Addressing Mechanism, Physical Layer.Connecting Devices: Hubs, Switches, Virtual LANs: Membership, Configuration, Communication between Switches, Advantages.Network Layer services: Introduction, Packetizing, Routing and Forwarding, Other services, Packet Switching: Datagram Approach, Virtual Circuit Approach, IPV4 Addresses: Address Space, Classfull Addressing, Classless Addressing, DHCP, Network Address Translation (NAT), Forwarding of IP Packets: Based on destination Address and Label.	10

4	**Network Layer Protocols:** Internet Protocol (IP): Datagram Format, Fragmentation, Options, Security of IPv4 Datagrams, ICMPv4: Messages, Debugging Tools, Unicast Routing: Introduction, Routing Algorithms: Distance Vector Routing, Link State Routing, Path vector routing, Unicast Routing Protocol: Internet Structure, Routing Information Protocol (RIP), Open Shortest Path First(OSPF), Border Gateway Protocol(BGP). Multicast addressing Scheme, Routing Protocols- PIM, IPV6 Protocol,IPV6 Packet format, Transition from IPv4 to IPv6.	10
5	**Transport Layer:** Introduction: Transport Layer Services, Connectionless and Connection Oriented Protocols, User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Connection, State Transition diagram, Windows in TCP, TCP congestion control.	10

SLE: Electronic Mail (SMTP), HTTP, FTP, socket programming: Creating network applications with both UDP and TCP on any network simulator (open source like NS2, Wire mesh etc.).

Text Books:

1. **Behrouz AForouzan,**"*Data Communication and Networking*",4th Edition, Tata McGraw-Hill Education,2010.
2. **James F. Kurose, Keith W. Ross,**"*Computer networking- A Top-Down Approach*",6th Edition, Pearson education, 2013 (EBook available on web).
3. **Wayne Tomasi,** "*Introduction to Data Communication and Networking*",1st Edition, Pearson education, 2007.
4. **Andrews S Tannenbaum, "***Computer Networks*", Pearson Education, 5th Edition.

Reference Books:

1. **Behrouz A Forouzan,** "*Data Communication and Networking*",5th Edition,McGraw-Hill, 2017 (EBook available on web).

Web Resources:

1. https://nptel.ac.in/courses/106105081/

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC520	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	3	0	0	3	3	0	0	0	0	0	0	0	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: CMOS VLSI Circuits	***Course Code: 20EC630***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic electronics.

Course Objectives: To learn basic CMOS Circuits, CMOS process technology, CMOS circuits that realize specified digital functions, understanding of the characteristics of CMOS circuit, apply CMOS technology-specific layout rules and be able to design CMOS combinational and sequential logic at the transistor level.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the CMOS Logic, VLSI Design flow and the CMOS Process technology.
CO2:	Analyze the characteristics of MOS device to compute the performance parameters and interpret results of CMOS circuits.
CO3:	Develop the combinational and sequential circuits for given specification.
CO4:	Demonstrate the working of Dynamic Logic Circuits and Semiconductor memories using EDA tool.

Unit No.	Course Content	No. of Hours
1	Introduction: A Brief History, MOS Transistors, CMOS Logic, CMOS fabrication and Layout, VLSI Design Flow, Fabrication, Packaging, and testing.	8
2	MOS Transistor Theory: Introduction, Ideal I-V Characteristics, C-V Characteristics, Non ideal I-V Effects, DC Transfer Characteristics, Switch - level RC Delay Models.	8
3	Circuit Characterization and Performance Estimation**:** Introduction, Delay Estimation, Logical effort and transistor sizing, Power Dissipation, Interconnect, Design Margin, and Reliability.	8
4	Sequential circuit design: SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, D-Latch and Edge-Triggered Flip-Flop.	8
5	Dynamic Logic Circuits - Voltage Bootstrapping Synchronous Dynamic Circuit Techniques High-Performance Dynamic CMOS Circuits and Semiconductor Memories: ROM, SRAM, DRAM circuits.	7

SLE Component	Analyze the characteristics and compute the read / write operation of SRAM cell. Design and Develop the PLL for high frequency (5-GHz) applications.

Text Books:

1. **Neil H.E. Weste, David Harris, Ayan Bannerjee: "**CMOS *VLSI DESIGN: A Circuits and Systems Perspective,"* 3rd Edition, Pearson Education, 2005.
2. **Douglas. A. Pucknell, Kamran Eshragian:***"Basic VLSI Design,"* 3rd Edition, Prentice-Hall of India, 2006.

Reference Books:

1. **R. Jacob Baker:** *"CMOS Circuit Design, Layout, and Simulation,"* 3rd Edition, John Wiley & Sons, Inc, Publication, 2010.
2. **Sung-Mo Kang, Yusuf Leblebici:** *"CMOS Digital Integrated Circuits Analysis and Design,"* 2nd Edition, McGraw Hill, 2003.

Web Resources:

1. https://youtu.be/Gv5fESGW2Ms?list=PLNhFkFk6qEgLxC8XgE38cYNgI1wldYxXZ

2. https://youtu.be/lRpt1fCHd8Y?list=PLCmoXVuSEVHlEJi3SwdyJ4EICffuyqpjk

3. https://youtu.be/o9vEnzLL-lY?list=PLojsqdbIzJGQtub91c4fF-TcCdzVYAInM

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC630	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	3	0	0	0	0	0	0	0	0	3	0
CO4	0	3	0	0	3	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: CMOS VLSI Lab	***Course Code: 20EC67L***
Credits : 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Student should complete the course on CMOS VLSI

Course Objective: Apply the concepts of basic combinational logic circuits, sequential circuit elements, and to develop familiarity and confidence with designing, building and testing digital circuits, including the use of CAD tools

Course Outcomes: After completing this course, students should be able to:

CO1:	Design and validate CMOS VLSI logic circuits using CAD tool.
CO2:	Demonstrate by simulating combinational and sequential circuits using CAD tool.

Expt No.	Experiment Name	No. of Hours
1	CMOS Inverter circuit.	3
2	CMOS NOR and NAND gates.	3
3	CMOS XOR, XNOR, OR, NOR gates.	3
4	Multiplexer and Demultiplexer.	3
5	Common Source amplifier circuit.	3
6	Common drain circuit.	3
7	CMOS Comparator circuit.	3
8	Flip Flops: SR, D, JK and T.	3
9	4-Bit Binary Counter.	3
10	BCD Counter.	3
11	6T SRAM Cell.	3
12	3T DRAM.	3
13	SAR ADC	3

Text Books:

1. **R. Jacob Baker:** *"CMOS Circuit Design, Layout, and Simulation,"* 3rd Edition, John Wiley & Sons, Inc, Publication, 2010.
2. **Sung-Mo Kang, Yusuf Leblebici:** *"CMOS Digital Integrated Circuits Analysis and Design,"* 2nd Edition, McGraw Hill, 2003.

Reference Books:

1. **John f walkerly,** "*Digital design principles and practices*", 3rd ed., phi/pearson education, 2005.

Web Resources:

1. https://www.youtube.com/watch?v=u0WgSMa1hrc&list=PLK2eyR1C9gjr7j-YoL_-JwJmjU6lNZGTO

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC67L	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	0	3	3	0	3	0	0	0	0	0	0	0	3	0	0
CO2	0	0	3	3	3	0	0	0	0	0	3	0	3	3	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Networking Lab	***Course Code: 20EC68L***
Credits : 1.5	***Total Contact Hours (L:T:P): 0:0:30***
Type of Course: Laboratory	***Category: Professional Core Course***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Student should complete the course on Computer Networks.

Course objective:
This course will enable student's to choose suitable tools to model a network and understand the protocols at various OSI reference levels. Design a suitable network and simulate using a Network simulator tool.

Course Outcomes: After completing this course, students should be able to:

CO1:	Design and Analyze Various Routing protocols and addressing schemes by creating various network configurations.
CO2:	Demonstrate and analyze the requirements and configurations for various IoT domain applications.

EXP No.	Lab Experiments Simulation experiments using CISCO Packet Tracer Tool / IoT Kit	No. of Hours
1.	Study of different types of Network cables and practically implement the cross-wired cable and straight through cable using clamping tool. **Using CISCO packet Tracer, perform the following experiments** i) Configure a basic Network topology. ii) Ping and Trace. iii) Investigate Unicast, Broadcast and Multicast Traffic.	3
2.	**Using CISCO Packet Tracer, Perform the following experiments** a. Subnetting – FLSM (Fixed Length subnet mask) b. Subnetting – VLSM (Variable Length subnet Mask)	3
3.	Configure a Network topology using Distance Vector Routing protocol (RIP).	3
4.	Configure a Network topology using Link State Routing protocol (OSPF).	3
5.	**Using CISCO Packet Tracer, Perform the followings** a. Network Address Translation (NAT) b. Access Control List (ACLs)	3
6.	**Using packet Tracer, perform the following experiments** a. Basic switching configuration. b. Configure VLAN and Inter-VLAN routing for a Network. **Using Wireshark tool, perform the following experiments** a. Packet Capture using Wireshark b. Viewing captured Traffic and analysis of packets.	3
7.	a. Familiarization with concept of IOT, Arduino/Raspberry Pi and perform necessary software installation. b. StudyofConnectivityandconfigurationofRaspberry-Piwithbasic peripherals,LEDS.UnderstandingGPIOanditsuseinprogram.	3
8.	Configuration of Raspberry pi with SenseHat Device and use python library for reading and storing of sensor data from SenseHat.	3
9.	Develop an prototype of IoT application for Smart Light home automation and	3

	Home Intruder detection system.	
10.	a. Demonstrate the concept of MQTT in IoT application. b. Write a socket programming for Client-Server Model.	3
11.	Write a python program to implement Dijkstra's algorithm/ Bellman's ford algorithm to compute the shortest routing path.	3
12.	Write a python program to compute minimum cost spanning tree using kruskal's/Prim's algorithm.	3
13.	Write a python program to implement client and server program.	3

References

1. **Todd Lammle, "***CCNA Routing and switching complete study Guide*", 2nd Edition, SYBEX, 2013.
2. **ArshdeepBahga** "*Internet of Things*", Universities press,2015.

Course Outcomes	**Program Outcomes**												**PSO's**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	3	3	0	0	0	0	0	0	0	0	0	0	0	3
CO2	3	3	3	3	0	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Design and Implementation Lab (mini project)	***Course Code: 20EC69P***
Credits : 2	***Total Contact Hours (L:T:P): 0:0:4***
Type of Course: Laboratory	***Category: Mini project***
CIE Marks: 50	***SEE Marks: --***

Course Objective: Course will help students manage the database and maintain a list of activities, and students will be lectured/supervised to carry hardware software project with their own ideas.

Course Objectives:

1. To generate new innovative interdisciplinary ideas leading to products/solutions.
2. To generate a methodology to realize the ideas.
3. To create a mathematical design and implementation the same (prototype development)
4. To carry out tests and Analysis (functionality test, performance analysis)
5. To prepare a Report and write an article on the work for publishing (Local news print / Magazines)

Course Outcomes: After completing this course, students should be able to:

CO1	Develop orientation to solve society relevant problems using technology through literature survey and real-world interaction.
CO2	Design Prototype Mathematical model/circuit , using modern tools to build/realize modules
CO3	Demonstrate results as a team, write technical report & article adhering to ethical standards

Unit No.	Course Content	No. of Hours
1	Literature survey : Prominent journals to be referred (SCI, Scopus, Taylor and Francis, IEEE,), Journal quality metrics,	2
2	Design and Implementation : Philosophy of design, stages of design, specifications and feasibility(Technical and Financial) , case examples	6
3	Design validation and Result analysis and improvement	2
4	Documentation : Preparing a Report and writing Article (Emphasizing on LATEX)	2
5	Demonstration	1

Reference Book :

1) **Ten Must reads on Design thinking, HBR press , ISBN- 1633698807**

Web Resources:

1) **www.ieee.org**
2) **www.scimagojr.com**
3) **Reference journals/Magazines**
    a. IEEE Journals
    b. Electronics circuit design magazines (EFY)

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC69P	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	0	3	0	3	2	2	2	3	2	0	2	1	2
CO2	0	3	3	3	3	0	0	2	2	2	0	0	3	3	3
CO3	0	0	0	0	0	0	0	3	3	3	2	3	1	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Rubrics and CO coverage:

Phase -1 (CO1)	Literature survey & Synopsis Preparation	**10 marks**	
Phase -2 (CO2)	a)Design evaluation b) Mid results	**20marks** **20 marks**	
Phase -3 (CO3)	Final Demo	**15marks**	
Report preparation (CO3)	Final Copy	**15marks**	
Observation book/ Article Writing and Technical Paper and Attendance	Final copy	**5+10+5 =20marks**	
TOTAL		**100marks**	Reduced to half

Course Title: Essence of Constitution of India and Professional Ethics	***Course Code: 20HU611 / 20HU612***
Credits (L: T:P): 2:0:0	***Total Contact Hours (L:T:P): 26:0:0***
Type of Course: Theory	***Category: Humanities***
CIE Marks: 50	***SEE Marks: -***

Course Objectives:

1. To provide basic information about Indian Constitution.
2. To identify individual role and ethical responsibility towards society.

Course Outcomes (COs):

1. Have general knowledge and legal literacy and thereby to tale up competitive examinations.

CO-PO Mapping (Articulation Matrix):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2	1	3				

Syllabus:

Unit-1: Introduction to the constitution of India, The Making of the Constitution and Salient features of the Constitution. **(2 Hours)**
Preamble to the Indian Constitutional Fundamental Rights & its limitations. **(3 Hours)**

Unit-2: Directive principles of State Policy & Relevance of Directive principles of State Policy Fundamental Duties. **(2 Hours)**
Union Executives – President, Prime Minister, Parliament, Supreme Court of India. **(3 Hours)**

Unit-3: State Executives – Governor, Chief Minister, State Legislature, High Court of State. **(2 Hours)**
Electoral Process of India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th, and 91st Amendments. (**3 Hours)**

Unit-4: Social Provision for SC & ST Special Provision for Women, Children and Backward Classes, Emergency Provisions. **(3 Hours)**
Powers and Functions of Municipalities, Panchayats and Co-operative Societies. **(2 Hours)**

Unit-5: Scope and Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility. **(3 Hours)**
Risk, Safety and liability of Engineers, Honesty, Integrity and Reliability in Engineers. **(3 Hours)**

Course Title: Robotics and Computer Vision	***Course Code: 20EC641***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Control Systems, Linear Algebra

Course Objective: To develop conceptual and analytical skills for students in Robotics and Computer Vision. To inculcate software and hardware skills to analyze, navigate and control robotics systems equipped with or without vision based sensors.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain mathematically, the position and orientation information of the object in an environment.
CO2:	Analyze the techniques to estimate the location of robot and navigate.
CO3:	Apply image processing and computer vision algorithms for robotics applications.
CO4:	Implement the kinematics concepts required to manipulate and control robot.
CO5:	Demonstrate the working of robots for the given specification using modern hardware and software tools.

Unit No.	Course Content	No. of Hours
1	**Representing position & orientation:** Pose in 2-dimensions, Pose in 3-dimensions, orthonormal rotation matrices, homogeneous transformation matrices, Euler angles, roll-pitch-yaw angles, gimbal lock, quaternions **Time & motion Trajectories:** 1-dimensional, multi-dimensional, multi-segment, Interpolation of rotation, Smooth Cartesian motion, Time-varying coordinate frames, angular velocity, Inertial navigation solution	8
2	**Mobile Robot Vehicles:** Mobility, Bicycle and Car like models, moving to a point, line & pose, Modeling of Quadcopter (Flying robots **Navigation**: Reactive navigation, Braitenberg vehicles, Bug* automata, Distance transform, D*Roadmap methods: Voronoi, PRM, RRT Localization EKF-based dead reckoning Map based Creating a map Localization	8
3	**Kinematics**: Forward kinematics, Inverse kinematics, Trajectories Assigning Denavit-Hartenberg parameters, Applications Velocity relationships Manipulator Jacobians, Resolve-rate motion control Force relationships, under and over actuated manipulators, **Dynamics & Control**: Independent Joint control, Rigid body equations of motion: gravity, inertia, Coriolis Forward dynamics, rigid body dynamics compensation.	8
4	**Computer Vision Fundamentals:** Light & color Spectral representation of light Color, color spaces, color gamut, color consistency, White balance Gamma correction, **Camera model:**Image formation Perspective imaging, **Image processing**: Acquiring images from files, cameras and the web, Image histograms, Monadic operation, Diadic operations, Spatial operations:	8

	convolution, template matching, rank filtering Morphology: image cleanup, skeletonization, hit-or-miss transform Shape changing: cropping, resizing, warping.	
5	**Image feature extraction:** Region features: segmentation, thresholding, MSER, graph-based Line features: Hough transform Point features. **Visual Servoing**: Position-based visual servoing (PBVS), Image feature motion due to camera motion, controlling feature motion — image-based visual servoing (IBVS), estimating depth.	7

SLE	Deep learning techniques for mapping and navigation of mobile robots

Text Books:

1. **Peter Corke,**"*Robotics, Vision and Control: Fundamental Algorithms In MATLAB"*, Second Edition, Springer, 2017
2. **S. K. Saha, "***Introduction to Robotics"*, 2nd Edition, McGraw Hill Education, 2017

Reference Books:

1. **Saeed B Niku, "***Introduction to Robotics: Analysis, Control, Applications"*, Student Edition, Wiley, 2011
2. **R. K. Mittal** and **I. J. Nagarath**: "*Robotics and Control"*, 6th Reprint, Tata Mcgraw-Hill Education, Delhi 2007.

Web Resources:

1. https://petercorke.com/
2. http://www.roboanalyzer.com/
3. https://nptel.ac.in/courses/107106090
4. https://www.youtube.com/channel/UCiK0J5wtnyX2jP-AiGbdhjg

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC641	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	3	0	0	0	0	0	0	0	0	0	3	3
CO5	3	3	3	3	3	0	0	3	3	3	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Nanodielectrics: Challenges and Opportunities	***Course Code: 20EC642***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts and fundamentals of dielectric materials used in capacitors.

Course Objectives:

1. To acquire fair knowledge on the characteristics of insulation materials.
2. To familiarize the testing and measurement of insulation for various equipments.
3. To gain knowledge on the advanced computer simulation techniques.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the concept, fundamentals of nanodielectrics in various applications.
CO2:	Apply the interface model to different characteristics of nanocomposites.
CO3:	Analyse the engineering performance of nanocomposites.
CO4:	Demonstrate the skill sets using software tools for simulation of composite films.

Unit No.	Course Content	No. of Hours
1	**Introduction**: Dielectrics and nanodielectrics, structure, preparation, and characterization of nanodielectrics, attractiveness of polymer nanocomposites.	8
2	**Preparation and structure:** Methods of mixing a quasi-spherical nanofillers into a polymer, surface modification of nanoparticles and its effects. Changes in the movement and structure of atoms and molecules represented by the dielectric properties, Structure of polymer/nanofiller interfaces.	8
3	**Compatibility with other engineering performances:** Electrical conductivity contrast between nanofillers and polymer matrix, electronic conduction effect on polymer/metallic nanoparticles, effect on dielectric breakdown strength, need of high-k and low-k materials, thermal and mechanical characteristics.	8
4	**Computer simulation methods:** Quantum mechanics with electronic states, molecular dynamics and Monte Carlo simulation with the collective motion of atoms and molecules, finite element method and statistical thermodynamics calculation with bulk materials, and phase-field method.	8
5	**Epilogue:** Nanodielectrics research challenges, environmental concerns and future prospects.	7

SLE: Nanodielectrics in energy storage, nanodielectrics in power sectors, aging behavior of nanodielectrics.

Text Books:

1. **Toshikatsu Tanaka**, **Takahiro Imai,** *"Advanced Nanodielectrics, Fundamentals and Applications"*, 1st edition, Jenny Stanford Publishing (Taylor and Francis), 2017.
2. **B.S. Murty et al,***"Textbook of Nanaoscience and Nanotechnology"*, 1st edition, Universities Press-IIM, 2012.

Reference Books:

1. **Sulabha K. Kulkarni**, "*Nanotechnology, Principles and Practices"*, 2nd edition, Capital Publishing Company, 2011.

Web Resources:

1. https://bajkulcollegeonlinestudy.in/StudyMaterialFinal/Chemistry/6th%20sem-DSE3 Nano%20structure%20%20-%20Dr.%20Sunirban%20Das.pdf
2. https://nptel.ac.in/courses/118102003

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC642	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	0	3	0	0	2	2	2	0	2	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Modern Wireless Communication Systems	***Course Code: 20EC643***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objective: To provide a comprehensive overview of existing wireless technologies.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain wireless communication channel and modulation techniques.
CO2:	Analyze wireless communication system channel modeling and IP mobility framework.
CO3:	Design multicarrier modulation schemes using simulation tools.
CO4:	Demonstrate the case studies through hardware/simulation for real time applications.

Unit No.	Course Content	No. of Hours
1	**Wireless Channel Modelling:** Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel - Capacity of Flat Fading Channel – Channel Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver, Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels.	8
2	**Multiple Antennas and Space Time Communications:** Narrowband MIMO model– parallel decomposition of the MIMO channel– MIMO channel capacity– MIMO diversity gain: Beam forming– Space time modulation and coding–Frequency selective MIMO channels.	8
3	**Multicarrier Modulation:** Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub-channels – Mitigation of Sub-carrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset.	8
4	**Wide band Code Division Multiple Access:** CDMA system overview - air interface – physical and logical channels – speech coding, multiplexing and channel coding – spreading and modulation: frame structure, spreading codes-uplink-downlink – physical layer procedures: cell search and synchronization-establishing a connection-power control-handover-overload control.	8
5	**IP Mobility Framework:** Challenges of IP Mobility -Address Management - Dynamic Host Configuration Protocol and Domain Name Server Interfaces – Security – Mobility-Based AAA Protocol - IP Mobility Architecture Framework - x Access Network - IPv6Challengesfor IP Mobility.	7

Text Books:

1. **Andrea Gold smith**, "*Wireless Communications*", Cambridge University Press, 2005.
2. **Andreas F. Molish,** "*Wireless Communications*", Wiley India, 2011.

Reference Books:

1. **Savo G. Glisic,** "*Advanced Wireless Communications and Internet: Future Evolving Technologies*", 3rd Edition, JohnWiley, 2011
2. **A. Paulraj, R. Nabar, D. Gore,** "*Introduction to Space-Time Wireless Communication*", 1st Edition, Cambridge University Press, 2008.

3. **T. S. Rappaport,** "*Wireless Communications*", 2nd Edition, Pearson Education, 2008.

Web Resources:

1. http://www.eecs.berkeley.edu/~dtse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter5.pdf
2. http://www.ece.mtu.edu/faculty/ztian/ee5530/sswireless.pdf
3. http://webmail.aast.edu/~khedr/Courses/Graduate/Wireless%20Communications_F08/Lecture%20six%20OFD M.pdf
4. http://cctlab.snu.ac.kr/nrl/w_ch06land.pdf

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC643	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	2	0	0	3	3	3	0	0	3	0	0	2	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Digital Image Processing	***Course Code:* 20EC644**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Students should be familiar with basic mathematics.

Course Objective: This course will enable the students to learn spatial, frequency domain image processing concepts and learn the grayscale and colour image processing techniques. The course will enable the students to analyze the different types of morphological and segmentation techniques.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the Theoretical foundation of Digital Image Processing in the spatial and frequency domain.
CO2:	Comprehend and apply various grayscale and color image processing techniques.
CO3:	Analyze various morphological transform and segmentation Technologies.
CO4:	Demonstrate the real-world application of image processing Technologies using modern Tools.

Unit No.	Course Content	No. of Hours
1	**Digital Image Fundamentals:** Elements of visual perception, Image sensing and acquisition, Image sampling and quantization, spatial and intensity resolution, Image interpolation and resampling. **Image Enhancement in Spatial Domain:** Basic gray level transformations, histogram processing, histogram equalization, histogram matching, enhancement using histogram statistics, image subtraction, averaging, smoothing and sharpening using spatial filters and their combination.	8
2	**Image Enhancement in Frequency Domain:** Frequency domain filtering fundamentals, Correspondence between filtering in spatial and frequency domain, smoothing and sharpening using Butterworth and Gaussian Low pass and High pass filters, The Laplacian in the frequency domain, Unsharp masking, High boost filtering, High frequency emphasis filtering, Homomorphic filtering. Color image processing: Color models RGB, CMY, CMYK, HSI, Color transformations, Converting colors from RGB to HSI and HSI to RGB, Pseudo color image processing.	8
3	**Basic Morphological Algorithms:** Dilation and erosion, Opening and closing, The Hit or Miss transformation, Boundary extraction, Region filling, Extraction of connected components, Convex Hull, Thinning, Thickening and Pruning.	8
4	**Wavelet Transforms:** Matrix-based Transforms, Correlation, Fourier – Related Transforms, Walsh-Hadamard Transforms, Slant transform, Haar Transform, Wavelet Transforms. **Image segmentation:** Point, line and edge detection (Robert, Canny and Prewitt techniques), Thresholding, Basic global thresholding, optimum global thresholding using Otsu's method.	8
5	Image Compression: Fundamentals, some basic compression methods-Huffman, Arithmetic and LZW coding techniques, Fractal image Compression, Digital image watermarking.	7

SLE (If Necessary)	Pattern recognition problems from recent journal publications.

Text Books:

1. **Rafael C. Gonzalez & Richard E. Woods:** "*Digital Image Processing***"**, 4th edition, Pearson Prentice Hall, 2018.

Reference Books:

1. **Anil K. Jain**, "*Fundamentals of Digital Image Processing***"**, Prentice Hall India, 2016.
2. **John C Russ**, "*The Image Processing Handbook"*, 5th edition, CRC Press, 2006.
3. **Maria Petrou and Costas Petrou**, "*Image Processing: The Fundamentals***"**, 2nd Edition, Wiley Blackwell, 2010.

Web Resources:

1. https://nptel.ac.in/courses/117105079/

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program-specific outcomes		
20EC645	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	0	0	0	0	0	2	2	0	2	0	1	0	2
CO2	3	2	1	1	0	0	0	2	2	0	2	0	2	2	3
CO3	3	2	2	1	0	0	0	2	2	0	2	0	3	2	2
CO4	3	3	3	3	3	2	0	0	3	0	2	2	2	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Mechatronics	***Course Code: 20EC645***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Control Systems, Microcontrollers.

Course Objective: The course is designed for graduate students to understand the concept of mechatronics, learn design principles to integrate multidisciplinary components as a system to meet requirements of products, and gain the fundamental knowledge about robots and automation

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the working principle of various sensors and actuators for Mechatronics applications.
CO2:	Analyze the analog, digital PID controllers and driving circuits
CO3:	Validate the pose and motion of manipulators and mobile robots.
CO4:	Compare various Microcontrollers for Mechatronics applications.

Unit No.	Course Content	No. of Hours
1	Introduction and examples of mechatronic systems. Review of Sensors, transducers and actuators: Static and dynamic characteristic of transducers, Displacement, Position, Velocity, Acceleration, Temperature, Motion, Orientation (gyroscope) sensors and their principle of operation. Digital encoders.	8
2	Hydraulic and Pneumatic Actuating Systems: System structure and signal flow, Hydraulic pumps, pressure regulation, Kinematic chains, Cams, Gears, Gear train, DC motor, PMDC, Brushless DC motors, Servo mechanism, Stepper motor, AC motor, PWM circuits, Design of Driver circuits, H bridge circuits	8
3	Process controllers: Proportional, Integral, Derivative, PI, PD, PID, Tuning, Pneumatic control, Digital PID Controllers, Adaptive control, Programmable Logic Control: Architecture and components, PLC programming, Ladder diagrams, Ladder circuits	8
4	Robotics: Representation of pose in 2D, 3D, DH parameters, Links and Joints, Forward kinematics, Inverse kinematics, Mathematical modeling of Mobile robots, Quadrotors, drones	8
5	Architecture of Raspberry Pi, Raspberry Pi Pico, Arduino, PIC, ARM Microcontrollers and their Comparison, 3D Printing: working principle, types, printing materials	7

SLE	Survey of recent papers in international journals on mechatronics applications.

Text Books:

1. **K. P. Ramachandran, G. K. Vijayaraghavan, M. S. Balasundaram,**"*Mechatronics: Integrated Mechanical Electronic System*", Wiley India, 2019.
2. **William Bolton,**"*Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*", 6th Edition, Pearson, 2019.
3. **S. K. Saha,**"*Robotics: Introduction to Robotics"*,2nd Edition, McGraw Hill Education, 2017

Reference Books:

1. **John M Jordan,**"*3D Printing*", The Illustrated Edition, MIT Press, 2019.
2. **Simon Monk**, "Programming the Raspberry Pi", McGraw Hill, Third Edition, 2021.

Web Resources:

1. https://www.digimat.in/nptel/courses/video/112107298/L01.html
2. https://www.youtube.com/watch?v=nARjnGLX5Mw&list=PLl9pgu4mXIvBgpo4vcWw5aUYOAwGs-KbW

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC645	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Operating Systems	***Course Code: 20EC646***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: To understand what a process is and how processes are synchronized and scheduled. To understand different approaches to memory management Students should be able to use system calls for managing processes, memory and the file system.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the principles of computer architecture, structure & functionalities for different operating system
CO2:	Analyze the core functionalities of operating system.
CO3:	Evaluate different algorithms with their core functionalities to improve system performance.
CO4:	Demonstrate/Implement algorithms as a team member for Operating system functions using programming languages.

Unit No.	Course Content	No. of Hours
1	**Introduction and Overview of Operating Systems:** Computer system overview , Goals and Operation of an O.S, Evolution of OS Classes of operating systems, Structure of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel-based operating systems, microkernel based OS.	8
2	**Process Management**: Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads. Fundamentals of scheduling, Long-term scheduling, Medium and short term scheduling, real time scheduling, Case studies.	8
3	**Memory Management:** Memory allocation preliminaries, Contiguous and noncontiguous allocation to programs, Memory allocation for program controlled data, kernel memory allocation, Case studies. **Virtual Memory:** Virtual memory using paging, Demand paging, Page replacement, Page replacement policies, Memory allocation to programs, Page sharing.	8
4	**File Management, Deadlock and File Security Techniques:** File organization, File sharing, File system security. Deadlocks in resource allocation, deadlock detection & resolution, dead lock prevention, deadlock avoidance. Computer security concepts, Access control and intrusion detection, Case studies.	8
5	**Prototypes:** TinyOS, SOS, Contiki, LiteOS	7

SLE : 1. Study of structure of different operating systems
2. Process management and scheduling algorithms in different operating systems
3. Memory management and file system in different operating systems.

Text Books:

1. **D.M.Dhamdhare,***"Operating SystemsA Concept based Approach"***,** 3rd Ed,TMH, 2006.

2. **WaltenegusDargie, Christian Poellabauer**, **"***Fundamentals of Wireless Sensor Networks: Theory and Practice"*, A John Wiley and Sons, Ltd., Publication, January 2011.

3. **Willaim Stallings,** *"Operating System – Internals and Design Systems"***,** 6th Ed, Pearson Education, 2009.

Reference Books:

1. **Pramodchanrdra**,*"An introduction to operating systems concepts and practice "*,3rd Ed ,PHI, ,2010

2. **Silberschatz and Galvin,** *"Operating Systems Concepts"***,** 8th Edition, John Wiley, 2001.

Web -Resource:

1. https://onlinecourses.nptel.ac.in/noc17_cs29/student/home
2. http://www.uobabylon.edu.iq/download/M.S20132014/Operating_System_Concepts,_8th_ Edition[A4]

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC646	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	0	0	3	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	0	3	0	0	0	3	2	0	2	2	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Automotive Cyber Security	***Course Code: 20EC647***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course-II***
CIE Marks: 50	***SEE Marks: 100***

Course Objective

1. To understand the Cybersecurity awareness and competencies in the automotive industry.
2. To learn all areas around automotive development being impacted by cybersecurity.
3. Prepared to implement appropriate cybersecurity measures

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the security requirements in IT/computer & embedded systems and understand the importance of security system in automotive domain.
CO2:	Apply the knowledge of security architecture, HW & SW solutions for security challenges in automotive domain.
CO3:	Analyze & model the security feature use cases.
CO4:	Demonstrate the threats & risks in security feature requirement use cases.

Unit No.	Course Content	No. of Hours
1	**Introduction to Cryptography and related Infrastructure**; Motivation & Security Basics: Current trends & Development, Safety and Security, Cryptography Concepts: Encoding, Encryption, Hash, Security services, Examples of Algorithm (AES 128, RSA)	8
2	**Signature & Encryption**, Symmetric & Asymmetric signatures. Public Key Infrastructure: Digital Certificate, Functions of PKI, Certifying Authority, Hierarchy of Certifying Authority **Layered automotive security**, CIA Triad.	8
3	**Security Architecture:** Software and Hardware Solutions - Introduction to Hardware Security Module (HSM), HSM and Software Crypto Libraries, Software & Hardware Encryption. Autosar Software Architecture overview, Introduction to Autosar Communication stack Crypto stack & Diagnostic Stack.	8
4	**Automotive Security Features:** Challenge- Response Protocol, Secure Access, Secure Flashing. Secure On-Board Communication, Secure Boot, Secure storage, Secure Logging. Case study topics will be provided by BGSW. Analysis and Presentation to be done by JSS students.	8
5	**Security Functional Testing**- Overview; Security Features Validation: Penetration Testing-Overview, Methodology, Types of Penetration Testing. Threat and Risk Analysis in Security Case study topics will be provided by BGSW. Analysis and Presentation to be done by JSS students.	7
SLE	Project work on development of any security feature prototype. For ex: Use	

	Oracle/SQL Server for PKI, Develop an application on Linux or in any user friendly environment and Execution Project topics and Mentoring will be provided by BGSW. The Project will be carried by JSS students in the College Lab and submit to BGSW.	

Text Books:

1. **William Stallings,"***Cryptography and network security principles and practice*", 7th edition, Pearson Education,2017
2. **Kerstin Lemke, ChristofPaar, Marko Wolf, "***Embedded Security in Cars"*, Springer Edition.

Reference Books:

1. **Kleidermacher David,**"*Embedded Systems Security"*, Elsevier Science & Technology
2. **Nina Godbole,SunitBelapure,**"*Cyber Security",* Wiley

E-resources:

1. https://link.springer.com/chapter/10.1007/978-981-16-2217-5_3

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

20EC647	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2		2											2	2	
CO3		3												2	2
CO4			3	3	3	2		3	3	2	2	2		2	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

VII Semester

Course Title: Innovation, Entrepreneurship and Management	***Course Code: 20EC710***
Credits: 4	***Total Contact Hours (L:T:P): 52:0:0***
Type of Course: Theory	***Category: Humanities***
CIE Marks: 50	***SEE Marks: 100***

Prerequisite: We welcome students from all over the world and consider all applicants on an individual basis.

Course Objective: The Management Core provides a broad business overview and the Innovation and Entrepreneurship core teaches you how to create, deliver and capture value from innovation.

Course Outcomes: After completing this course, students should be able to:

CO1	Identify the outcomes of innovation with respect to IPR and patents in technology-oriented business.
CO2	Explain entrepreneurship, Management and Innovation with an emphasis on their evolution.
CO3	Analyze the importance of technology management with respect to organization, finance, ethics, team work and project planning.
CO4	Investigate techno-economic feasibility of a project.
CO5	Develop a business plan and exhibit various successful entrepreneurial profiles

Unit No.	Course Content	No. of Hours
1	Introduction to Innovation: Creativity, Invention and innovation, Types of Innovation, Relevance of Technology for Innovation, The Indian innovations and opportunities, Strategy for Commercializing Innovation: Innovation Process, Risks and barriers for introducing products and services, selecting a Strategy, setting up the Investment and establishing organization, Evaluating the Costs and impact of the Project.	10
2	**Entrepreneurship:** Concept, meaning, need and competencies/qualities/traits of an entrepreneur, Technopreneurship. Innovation: Introduction, motivating to innovate, introduce core ideas about how to think about innovation, including key theories about factors that affect innovation. An in-depth review of how companies' structure to encourage and develop innovation. Product development and design.	10
3	**Role of financial institutions:** Role of financial institutions in entrepreneurship development and support Institutes: District Industry Centers (DICs), State Financial Corporations, Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Small Industries Corporation (NSIC) and other relevant institutions. Market Survey and Opportunity Identification: start-up industry, procedures for registration of industry. assessment of demand and supply in potential areas of growth, understanding business opportunity, considerations in product selection and development, data collection for setting up new ventures.	10
4	**Engineering Management**: Introduction to Engineering Management: Engineering	10

	and Management, historical development of engineering management. Functions of management: planning and forecasting, decision making, organizing, motivating and leading technical people, controlling. **Technology management:** Managing projects: Project planning and acquisition, organization and types, leadership and control. Case Studies	
5	**Project Report Preparation:** Preliminary report, Techno-economic feasibility report, Project viability. Case studies examples	12

Text Books:

1. **Peter Duckers, "**Innovation and Entrepreneurship Practice and Principles", Heinnemann, 1985.
2. **Morse and Babcock, "**Managing Engineering and Technology", 4th edition, PHI Learning Private Limited, New Delhi, 2009.
3. **Rabindra N. Kanungo** "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.
4. **Peter F. Drucker**, "Innovation and Entrepreneurship"

Reference Books:

1. **Barringer, Duane**, "Entrepreneurship Successfully Launching New Ventures", 4th edition, Prentice Hall, 2009.
2. **Weihrich, Cannice, Koontz**, "Management: A Global, Innovative and Entrepreneurial Perspective", 14 e, McGraw Hill Education (India) Private Limited, New Delhi, 2013.
3. **Ulrich, Eppinger, Goyal,**"Product Design and Development", 4th edition, Tata McGraw Hill Education (India) Private Limited, New Delhi, 2008.
4. **Vasant Desai**, "The dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 2012.
5. **J. Tidd, J. Bessant and K. Pavitt**, "Managing Innovation: Integrating Technical", Market and Organizational Change, Wiley, 3rd edition, 2005.

ESSENTIAL READING:

1. Robin Lowe and Sue Marriott, Enterprise: Entrepreneurship and Innovation Concepts, Contexts and Commercialization
2. John Bessant and Joe Tidd, Innovation and Entrepreneurship

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC710	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0
CO4	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0
CO5	3	3	3	3	3	3	2	3	3	3	3	3	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Speech Processing using Deep Learning	***Course Code:* 20EC721**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Students should be familiar with basic mathematics.

Course Objective: To make students learn the fundamental concepts of speech, deep learning and study about feature extraction and classification techniques using deep learning algorithms.

Course Outcomes: After completing this course, students should be able to:

CO1:	Comprehend the theoretical foundation of speech processing and deep learning.
CO2:	Analyze speech feature extraction recognition techniques.
CO3:	Apply deep learning and CNN Architecture and algorithm.
CO4:	Implement Neural network and machine learning algorithms for real-world applications.

Unit No.	Course Content	No. of Hours
1	**Phonetics:** Speech Sounds and Phonetic Transcription, Articulatory Phonetics, Phonological Categories, and Pronunciation variation, Acoustic Phonetics, and Signals, Phonetic Resources, Advanced: Articulatory and Gestural Phonology, Text Normalization, Phonetic Analysis, Prosodic Analysis, Diphone Waveform Synthesis, Unit Selection Synthesis.	8
2	**Automatic Speech Recognition:** Speech Recognition Architecture, The Hidden Markov Model Applied to Speech, Feature Extraction: MFCC Vectors, Acoustic Likelihood Computation, Embedded Training, Evaluation: Word Error Rate.	8
3	**Basics of Deep Learning:** Introduction,Perceptron Algorithm Explained**,** Multilayer Perceptron, Deep Learning, Model Training, Unsupervised Deep Learning, Framework Considerations	8
4	**Convolutional Neural Networks:** Basic Building Blocks of CNN, Forward and Backpropagation in CNN, Text Inputs and CNNs, Classic CNN Architectures, Modern CNN Architectures, Applications of CNN in NLP, Fast Algorithms for Convolutions	8
5	**Applications and User Interfaces:** Application Architecture, Typical Applications, Computer Command and Control, Telephony Applications, Dictation, Accessibility, Handheld Devices, Automobile Applications, Speaker Recognition **Speech Interface Design:** General Principles, Handling Errors, Dialog Flow. Internationalization	7

SLE	Pattern recognition problems from recent journal publications.

Text Books:

1. **Daniel Jurafsky, James H. Martin** "*Speech and Language Processing*", Pearson, Second Edition,2017.
2. **Uday Kamath, John Liu, James Whitaker** "*Deep Learning for NLP and Speech Recognition*" Springer, 2019

3. **Xuedong Huang, Alex Acerd, Hsiad-wuen Hon** "*Spoken Language Processing: A Guide to Theory, Algorithm and System Development*" PH PTR, 2001.

Reference Books:

1. **Lawrence RabinerandBiing-Hwang Juang**, "*Fundamentals of Speech Recognition*", Pearson Education, 2003.
2. **Simon Haykin** "*Neural networks and Learning Machines*" Pearson, 3rd Edition. 2016.
3. **Tomm. Mitchell** "*Machine Learning*" McGraw Hill Education, 22nd reprint 2018.
4. **NilanjanDey** "*Intelligent Speech Signal Processing*"-Academic Press,2019
5. **Umberto Michelucci** "*Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks*" Apress, 2018.

Web Resources:

1. http://www.digimat.in/nptel/courses/video/117105145/L37.html
2. https://nptel.ac.in/courses/106106184

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program-specific outcomes		
20EC721	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														2
CO2		3												2	3
CO3			3	2									2	3	3
CO4	3	3	3	3	3	2		3	3	3	3	3	2	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Embedded Systems	***Course Code: 20EC722***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Prerequisite: Basic electronics, digital electronics, knowledge of microcontrollers and C programming.

Course Objective: The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions**.**

Course Outcomes: After completing this course, students should be able to:

CO – 1	Explain the major components that constitute an embedded system.
CO – 2	Analyze the basic structure of embedded systems.
CO – 3	Employ contemporary techniques for Hardware-Software co-design of embedded systems for Real time applications using RTOS.
CO – 4	Design real time embedded systems using the concepts of RTOS, simulate using modern software tools through group projects and give effective oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	**Introduction to Embedded Systems:** Embedded systems, Processor Embedded into a system, Embedded Hardware Units and Devices in a system, Embedded Software in a system, Examples of Embedded Systems, Embedded SOC and use of VLSI Circuit Design Technology, Complex system Design and processors, Design Process in Embedded system, Formalization of System Design, Design Process and Design Examples.	8
2	**Devices and Communication Buses for Device Network:** I/O types and examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing features in Device Ports, Wireless Devices, Timers and counting Devices, Networked Embedded Systems, Serial Bus Communication Protocols, Parallel Bus Device Protocols, Network Protocols, Wireless and Mobile system protocols.	8
3	**Device Drivers and Interrupt Service Mechanism:** Programmed I/O Busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing mechanism, multiple interrupts, DMA, Device Driver Programming, EDLC.	8
4	**Hardware Software Co-Design, Program Modeling, Embedded Firmware Design and Development:** Fundamental Issues in Hardware Software Co-Design, Computational models in Embedded Design, Hardware Software tradeoffs, Embedded Firmware Design approaches, Embedded Firmware Development languages, Programming in Embedded C.	8
5	**RTOS based Embedded System Design:** OS basics, Types of Operating Systems, Tasks, process and Threads, Multiprocessing and Multi-tasking, Task Scheduling, Threads, Processes and Scheduling, Task Communication, Task Synchronization, Device Drivers, how to choose an RTOS?	7

Text Books:

1. **Raj Kamal:** "*Embedded Systems - SoC, IoT, AI and Real-Time Systems*", 4th Edition, TMH, 2020.
2. **Shibu K V:** *"Introduction to Embedded Systems"*, 2nd Edition, TMH, 2017.

Reference:

1. **James K Peckol:** "*Embedded Systems- A Contemporary Design Tool*", 1st edition, John Wiley, 2019.
2. **Santanu Chattopadhyay,** "*Embedded System Design*", 2nd edition, PHI Learning, 2013

Web Resources:

1. https://nptel.ac.in/courses/108102045/
2. https://nptel.ac.in/courses/106105193/
3. https://nptel.ac.in/courses/106105159/
4. https://www.youtube.com/watch?v=JO4AEkOVF2M&list=PLrjkTql3jnm-lZMoUb1xMCp0HgxvJ7ocx
5. https://www.coursera.org/learn/introduction-embedded-systems

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC722	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
CO4	0	0	0	0	0	0	0	3	3	3	0	0	2	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Internet of Things (IoT)	***Course Code: 20EC723***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Course Objective: The Internet of Things (IoT) is everywhere. It provides advanced data collection, connectivity, and analysis of information collected by computers everywhere—taking the concepts of Machine-to-Machine communication farther than ever before. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions.

Course Outcomes: After completing this course, students should be able to:

CO1	Explain the fundamentals of Internet of Things and its building blocks along with their characteristics
CO2	Analyze the protocols and standards designed for IoT and the current research on it.
CO3	Implement interfacing of various sensors with Arduino/Raspberry Pi.
CO4	Simulate real time problems using modern software tools through group projects and give oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	**FUNDAMENTALS OF IoT:** Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.	8
2	**IoT PROTOCOLS:** IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 1901.2a and Lora WAN, Zigbee, RFID and NFC. Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks (AODV & DSR), Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP, MQTT, AMQP and XMPP.	8
3	**DESIGN AND DEVELOPMENT:** Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi.	8
4	**DATA ANALYTICS AND SUPPORTING SERVICES:** Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning	8

	– No SQL Databases, Hadoop Ecosystem, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, AWS for IoT, System Management with NETCONF-YANG.	
5	**CASE STUDIES/INDUSTRIAL APPLICATIONS:** Cisco IoT system, IBM Watson IoT platform, Manufacturing, Converged Plant wide Ethernet Model (CPwE), Power Utility Industry, Grid Blocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.	8

Text Books:

1. **RajkumarBuyya**: *Internet of Things: Principles and Paradigms*
2. **ArshdeepBahga**: *Internet of Things*, Universities press,2015
3. **Olivier Hersent**: *The Internet of Things*, Wiley student edition, Reprint, 2015

Reference Books:

1. **Raj Kamal**: *Internet of Things - Architectures and Design principles.*
2. **Jan Holler**: *From Machine-to-Machine to the Internet of Things*, Academic Press, 2014.

Web Resources:

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC723	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	3	0	0	0	0	2	0	0	0	0	0	0	2	0	0
CO4	2	2	0	0	0	2	0	0	1	1	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Quantum Computing and Communication	***Course Code: 20EC724***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of quantum mechanics and linear algebra operator and matrices.

Course Objective: Able to understand Fundamentals of quantum information processing, including quantum computation, the quantum circuit model, alternative models, Qubits, unitary operators, measurement, entanglement, quantum algorithms for factoring and search.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the Qubit, Bloch sphere representation and Density matrix for the basic principles of quantum computing
CO2:	Analyze the basics of quantum algorithms, including the techniques of Super Dense Coding and the quantum Fourier transform.
CO3:	Implement Quantum Fourier Transform for Qubits with error corrections and applications of information theory
CO4:	Design and demonstrate the classes of problems that can be expected to be solved well by quantum computers and document the same.

Unit No.	Course Content	No. of Hours
1	Introduction: Why Quantum Computing, Postulates of Quantum Mechanics, Qubit - The smallest unit and Bloch sphere representation, Multiple Qubit States and Quantum Gates and Quantum Circuits.	8
2	Quantum Teleportation, Super Dense Coding, Bloch Sphere and Density Matrix, Measurement Postulates.	8
3	Algorithms: Deutsch Algorithm, Deutsch-Josza & Bernstein-Vazirani Algorithms, Simon Problem, Grover's Search Algorithm, Shor's Factorization Algorithm.	8
4	Quantum Fourier Transform, Implementing QFT-3 qubits (and more), Quantum Error Corrections for different Qubits.	8
5	Shannon Entropy, Shannon's Noiseless Coding Theorem, EPR and Bell's Inequalities, Cryptography-RSA Algorithm, Quantum Cryptography.	7

Text Books:

1. **Michael A. Nielsen & Isaac L. Chuang,** "*Quantum Computation and Quantum Information"*, 10th Edition Cambridge University Press – 2010.
2. **Eleanor Rieffel and Wolfgang Polak,** "*QUANTUM COMPUTING - A Gentle Introduction*", 2nd Edition, MIT Press Cambridge, 2011.
3. **D. Bouwmeester, A. K. Ekert, and A. Zeilinger**, eds. "*The Physics of Quantum Information"*, Springer-2013

References:

1. **P. Kok and B. W. Lovett**, *"Introduction to Optical Quantum Information Processing"*, 1st edition, Cambridge university press – 2010.
2. **L. Mandel, and E. Wolf** "*Optical Coherence and Quantum Optic"s*, 1st edition, Cambridge University Press 1995

Web Resources:

1. https://youtu.be/xnmpWfQKPSE?list=PLo4DhXMUkdvU9rZvEQYLdly5dABHvlZuD
2. https://youtu.be/Vzh5guYUyvM?list=PLq-Gm0yRYwThGmlypvSFQ-kT2rPaXKAZ5

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC724	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	3	3	0	0	0	3	0	0	0	0	2	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Biomedical Signal Processing	*Course Code: 20EC725*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Professional Elective Course*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, evoked potentials, and EMG. 3. To understand Sources and characteristics of noise and artifacts in bio signals.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the concept and characteristics of biomedical signal.
CO2:	Apply the efficient algorithms for biomedical signals analysis.
CO3:	Analyze the basic knowledge of signal processing for biomedical signals.
CO4:	Implement an algorithm to study the characteristics of biomedical signals.

Unit No.	Course Content	No. of Hours
1	**Biomedical Signals:** Introduction to Biomedical Signals, The Nature and Examples of Biomedical Signals The electrocardiogram (ECG), The electroencephalogram (EEG), The phonocardiograrn (PCG), Basic electrocardiography: ECG lead systems :ECG signal characteristics, Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis	8
2	**Acquisition of Biomedical signals:** Introduction, principles, classification, various components of biosensors, Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions.	8
3	**Filtering and Features extraction methods:** Random noise, structured noise, and physiological interference , High-frequency noise in the ECG; Motion artifact in the ECG Powerline interference in ECG signals; Maternal interference in fetal ECG Potential solutions to the problem , Time-domain Filters, Frequency-domain Filters, Optimal Filtering: The Wiener Filter , Adaptive Filters for Removal of Interfere	8
4	**Bio-medical Instruments:** Medical imaging techniques: Basics of diagnostic radiology – Production – Nature and properties of X rays – X-ray machine – Block diagram – Digital radiography – CT – Basic Principle – Block diagram – Radioisotopes in medical diagnosis – Physics of radioactivity – Gamma Camera. Block diagram – SPECT Scanner – PET Scanner – Principles of NMR Imaging systems – Block diagram of NMR Imaging System – Ultrasonic Imaging Systems – Physics of Ultrasound waves – Doppler effect – Medical Ultrasound Electrical safety: Physiological effects of electricity. Micro & macro shock hazards – Electrical Safety codes and standards – Protection of patients.	8
5	**Analysis of Real-time Biomedical signals**: Automatic analysis and classification of ECG, P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Signal averaged ECG, Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, Analysis of PCG signal, Analysis of EMG signal	7

SLE: Future Trends in Neurosensors, Biosensors, Nano-technology, Soft Computing techniques in instrumentation.

Text Books:

1. **R M Rangayyan** "*Biomedical Signal Analysis: A case Based Approach*", IEEE Press, John Wiley & Sons. Inc, 2002
2. **Willis J. Tompkins** " *Biomedical Digital Signal Processing*", EEE, PHI, 2004
3. **D C Reddy** "*Biomedical Signal Processing: Principles and Techniques"*, Tata McGraw-Hill Publishing Co. Ltd, 2005.
4. **R S Khandpur**, "Handbook of Biomedical Instrumentation", 1st ed., Tata McGraw Hill Publishing Company Limited, 2004.

Reference Books:

1. **Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer,** "*Biomedical Instrumentation & Measurements,* 2nd ed., Pearson Education., 2001.
2. **Eugene N. Bruce,** *Biomedical Signal Processing and Signal Modeling*, John Wiley & Sons, 2000

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ee41/preview
2. https://www.coursera.org/lecture/interface-with-arduino/lecture-2-1-actuators-uNCa4

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC725	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	0	3	0	0	0	3	0	2	2	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

***Course Title:* Protocol Engineering**	***Course Code: 20EC726***
Credits (L:T:P): 3:0:0	***Total Contact Hours: 39:0:0***
Type of Course: Lecture	***Category: Professional Elective***
CIE Marks: 50	***SEE Marks: 50***

Pre-requisite: Course on Computer Networks.

Course Objectives: This course serves as an introduction for students seeking to acquire a fundamental of various communication protocols used in internet. Understanding its design requirements, methodology, verification, validation and its challenges in designing a protocol using graphical modelling language (SDL).

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamental concepts of communication protocol, its architecture, operations and design.
CO2:	Validate protocol testing, error testing procedures using different techniques and tools.
CO3:	Design and simulate simple protocols using formal and informal approaches.
CO4:	Demonstrate the knowledge of developing simple protocols, their testing and writing test cases keeping abreast of industry preferences.

Unit No.	Course Content	No. of Hours
1	**Introduction:** Introduction to communication protocols, software, subsystems development methods, protocol engineering process, reference models, services and interface protocols at various layers.	8
2	**Protocol specifications:** components of protocol, service specifications, entity specifications interface and interactions, examples (HDLC, ABP, RSVP etc).	8
3	**SDL:** Features, communication system using SDL, examples of SDL based protocol specifications, protocol verification, validation design errors, validation approaches, and examples.	8
4	**Testing:** Conformance testing, framework, conformance test architectures, test sequence generation methods, TTCN framework, examples.	8
5	**Protocol testing:** Types, performance testing, Interoperability testing, scalability testing. Protocol synthesis, protocol implementation requirements and methods.	7

Text Books:

1. **A. Leon –Garcia, IndraWidjaja** "*Communication Networks*", Tata McGraw Hill.
2. **W. Stallings** "*Data and Computer Communication*", 7th edition, PHI, New Delhi.
3. **PallapaVenkataram, Sunil Kumar S Manvi, B. SathishBabu**" *Communication ProtocolEngineering*", PHI, Learning, 2014.

Reference Books:

1. **Mohammed G. Gouda** *"Elements of Protocol Design"*, Wiley Student Edition, 2004.
2. **M.SteenStrub**"*Routing in Communication networks*", PH, New York.
3. **Sivarammurthy, Manoj** "*Ad Hoc Wireless Networks: Architectures and Protocols*",Pearson Education, 2004.
4. **Charles E. Perkins** "*Ad Hoc Networking*", Addison Wesley, 2008.

Web Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105183/

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

Course Outcomes	Program Outcomes												PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3
CO1	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	0	3	0	3	0	0	0	0	0	0	0	0	0	3
CO3	0	0	3	0	3	0	0	0	0	0	0	0	0	0	3
CO4	0	0	0	3	3	0	0	0	0	0	0	0	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Nanoscience and Technology	***Course Code: 20EC731***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of materials physics, chemistry, and usage of some simulation tools.

Course Objective: Describe the concepts and fundamentals of materials towards nanoscience and technology, by analyzing the engineering performance of the selected material.

Course Outcomes: After completing this course, students should be able to:

CO 1:	Describe the concept, fundamentals of materials towards nanoscience and technology.
CO 2:	Apply the fundamentals of analytical techniques and interface science to materials.
CO 3:	Analyze the engineering performance of nanoparticles.
CO 4:	Demonstrate the skill sets using software tools for the simulation of composite films or industry visit.

Unit No.	Course Content	No. of Hours
1	**Introduction:**Generic methodologies for nanotechnology- classification and fabrication, classification of nanostructures, nanoscale architecture, electronic properties of atoms and solids, effects of nanometer length scale, top-down process, bottom-up process, templating methods, ordering of nanosystems.	8
2	**Characterization techniques:** Classification, scattering physics, SEM, TEM, AFM, bulk and surface diffraction techniques, electron spectroscopy for surface analysis, infrared spectroscopy and Raman spectroscopy.	8
3	**Quantum wells, wires and dots:** Preparation of quantum nanostructures, size effects, conduction electrons and dimensionality, Fermi gas and density of states, potential wells, partial confinement, properties dependent on density of states, applications: infrared detectors and quantum dot lasers.	8
4	**Properties of nanoparticles:**Face centered nanoparticles, metal nanoclusters, magic numbers, theoretical modeling of nanoparticles, geometric and electronic structure, reactivity, fluctuations. Carbon molecules, structure, clusters, discovery, crystal and structure of C_{60}, larger and smaller fullerenes, carbon nanotubes, fabrication, structure, electrical, vibrational and mechanical properties, applications.	8
5	**Principles of interface science:** Surface and interface energies, analysis of wet interfaces, modifying interfaces, adsorption and surfactancy, polymer adsorption, chemistry of grafting, physical properties of grafted polymer layers, nanostructured organic coatings by soft lithography, making thin organic films, spin-coating of polymers and colloids, making organic multilayers.	7

SLE: Synthesis of various nanoparticles, fabrication methods of nanocomposites, nanoscience and nanotechnology applied towards innovative products.

Text Books:

1. **Ed Robert Kelsall, Ian Hamley, Mark Geoghegan,** "Nanoscale science and technology", John Wiley and Sons Pvt. Ltd., 2007.
2. **Charles P Poole, Jr, Frank J Owens** "Introduction to Nanotechnology", John Wiley and Sons Pvt. Ltd., Copyright 2006, Reprint 2011.

Reference Books:

1. **W. Gaddand, D. Brenner, S. Lysherski and G. J. Infrate (Eds),***"Handbook of Nanoscience Engineering and Technology"*, 1st edition, CRC Press, 2002.

Web resources:

1. https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf
2. https://onlinecourses.nptel.ac.in/noc19_mm21/preview
3. https://nptel.ac.in/courses/118104008

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC731	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2
CO4	0	0	0	0	3	2	2	2	2	2	0	0	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Statistical Signal Detection and Processing	***Course Code: 20EC732***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Digital Signal Processing

Course Objectives: This course will discuss methods for analysis of digital signals in noise. It will include the basics of Estimation Theory, Parametric, and Non-parametric spectrum estimation and filter models.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain signal models using deterministic and stochastic methods
CO2:	Apply signal models to various filter structures
CO3:	Analyze applications for prediction and power spectrum estimation
CO4:	Implement adaptive signal processing algorithms

Unit No.	Course Content	No. of Hours
1	**Overview of Random processes:** Stationary processes, Gaussian processes, Ergodicity, white noise, power spectrum **SLE:** spectral factorization	8
2	**Signal modeling:** Pade approximation, Prony's method, Autocorrelation method, Covariance method, AR, MA and ARMA models **SLE:** Least squares method	8
3	**Filter models:**Levinson recursion, Lattice filter: FIR and IIR, Wiener filter: FIR and IIR filter **SLE:** Kalman Filter	8
4	**Spectrum Estimation:** Nonparametric methods, Periodogram, Bartlett's method, Welch's method, Blackman-Tukey approach, Maximum Entropy method, Parametric Methods, Frequency estimation **SLE:** Yule-Walker and Burg method	8
5	**Adaptive filtering:** LMS and RLS algorithm, Linear Quadratic Gaussian filter. **SLE:**Adaptive Lattice-Ladder filter	7

Reference Books:

1. **Monson Hayes,** "*Statistical Digital Signal Processing and Modelling*", Wiley India 2014
2. **B. Widrow, S. Stearns,** "*Adaptive Signal Processing*", Latest Edition, Pearson 2015.
3. **D. G. Manolakis, V. K. Ingle and S. M. Kogon**, "*Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing*," McGraw-Hill, New York, 2000.

Web Resources:

1. NPTEL Video lecture by Prof S Mukhyopadhyay, IIT Kharagpur
   https://www.youtube.com/watch?v=Ru3FhYbjcFs&list=PL4FB9652402002C76

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC732	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	2	0
CO2	0	0	2	2	2	0	0	0	0	0	0	0	3	2	0
CO3	0	3	2	2	2	0	0	0	2	2	0	0	3	2	0
CO4	0	3	2	2	2	0	0	0	2	2	0	0	3	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Cryptography and Network Security	***Course Code: 20EC733***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Computer Networks.

Course Objective

1. To understand the Cybersecurity awareness and competencies in the automotive industry.
2. To learn all areas around automotive development being impacted by cybersecurity.
3. Prepared to implement appropriate cybersecurity measures

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamental concepts of network security and networking protocols.
CO2:	Analyze network security threats and counter measures.
CO3:	Design the network application security schemes.
CO4:	Demonstrate an ability to work individually or in a team to carry out assigned tasks, by effectively managing resources adhering to standard practices and ethics.

Unit No.	Course Content	No. of Hours
1	Introduction: Security goals, services, mechanisms and attacks. The OSI security architecture, Layers in the TCP/IP, A model for network security, Host to network interface protocols, network protocols, transport protocols, application protocols.	7
2	Security at the Application Layer: E-Mail architecture and security, E-Mail threats, PGP, Multipurpose internet mail extension, S/MIME functionality, S/MIME messages, S/MIME certificate processing, enhanced security services.	8
3	Security at the Transport Layer: SSL architecture, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol and shake Protocol, SSL message formats, transport layer security.	8
4	Security at the Network Layer: IPSec overview, Services provided by IPSec, Applications of IPsec, Security association, Security policy, Internet key exchange	8
5	Intruders, Intrusion Detection, Password Management. Malicious software: Viruses and Related Threats, Virus Counter measures. Firewalls Design Principles.	8
SLE	Block-chain technology, Bitcoin and Alternative Coins	

Text Books:

1. **William Stallings,** "*Cryptography and Network Security*",*7*th Edition, Pearson Education, 2017.
2. **Behrouz A. Forouzan,** "*Cryptography and Network Security*", 2nd Edition, TMH, 2011.

Reference Books:

1. **Kaufman, Perlman & Speciner,** "*Network security -Private communication in a public world*", 2nd Edition, PHI, 2005.
2. **Bishop Matt**: "*Introduction to Computer Security*", Dreamtech Press, 2013
3. **William Stallings**: "*Computer Security Principles*", 4th Edition, TMH, 2020

Web Resources:

1. https://nptel.ac.in/syllabus/106105031/
2. https://nptel.ac.in/courses/106105162/
3. https://www.youtube.com/watch?v=p6w9RZ5PNho

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC733	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	0	3	3	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	3	3	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	0	0	3	0	2	3	3	3	2	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Wavelet and compression techniques	***Course Code:*20EC734**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Students should be familiar with Linear algebra, Probability, and Image Processing.

Course Objective: To make students learn the signal representation and analyze the continuous, discrete-time signals and coding techniques using wavelet transform.

Course Outcomes: After completing this course, students should be able to:

CO1:	Utilize the concept of Vectors, Basis Sets for Signal Representation.
CO2:	Analyze discrete and continuous time signals using Wavelets
CO3:	Apply coding techniques, dictionary techniques and Quantization Techniques for the image.
CO4:	Demonstrate the real-world application of wavelets and compression techniques using modern Tools.

Unit No.	Course Content	No. of Hours
1	**Linear Algebra Review:** Vector spaces and basis, inner products, diagonalization, shift invariant linear transform, convolution and DFT, signal as vector representation using Fourier basis.	8
2	**Construction of discrete wavelets:** Mother wavelets and scaling function, first state wavelet basis, iteration, Multi resolution analysis, Filter bank, Up-sampling, Down sampling, Quadrature mirror filters and conjugate filters, Haar, Daubechies orthogonal wavelets, Biorthogonal Wavelets	8
3	**Coding Techniques:** Huffman coding, Adaptive Huffman coding, Applications of Huffman coding algorithm to text and audio processing, Arithmetic coding, generating and deciphering the tag, Comparison of Huffman coding & Arithmetic coding, Adaptive arithmetic coding and applications	8
4	**Scalar and Vector Quantization Techniques:** Scalar quantization, Uniform & Adaptive quantizer, Vector Quantization, Advantages of VQ over SQ, LBG algorithm. Transform coding: DCT, Quantization and coding of transform coefficients.	8
5	**Dictionary techniques:** Static/Adaptive dictionary techniques, Applications to File compression- UNIX compress, GIF image compression, JPEG, JPEG-LS lossless image compression techniques. Mathematical preliminaries for Lossy Compression techniques: Distortion criteria, conditional entropy, differential entropy, Models: physical, probabilistic, linear system models.	7

SLE: Construction of discrete wavelets, Construction of continuous wavelets, Sub-band Coding, Multi-resolution analysis, and scaling function,

Text Books:

1. **Michael Frazier**, "*An Introduction to Wavelets through Linear Algebra*", Springer Edition.
    a. 2013 Reprint.
2. **Khalid Sayood:** "*Introduction to Data Compression*", 4th Edition, Elsevier Inc, 2012.

Reference Books:

1. **Raghuveer M. Rao, AjitBopardikar**, "*Wavelet Transforms: Introduction to Theory and Applications*", Pearson Publication. 2014.
2. **David Solomon, Giovanni Motta:** "*Handbook of Data Compression*", 5th Edition, Springer, 2010.
3. **K. P. Soman, K I Ramachandran, N G Resmi,** "*Insight into Wavelets: From Theory to Practice*", PHI Eastern Economy Edition, 2014.

Web Resources:

1. https://www.youtube.com/watch?v=c4s5X-Bm2Wc&list=PLUYV0LEDKN9CQ-HT33K8ED6-f2tlxcN0Q
2. https://www.youtube.com/watch?v=c4s5X-Bm2Wc&list=PLUYV0LEDKN9CQ-HT33K8ED6-f2tlxcN0Q
3. https://nptel.ac.in/courses/108101093
4. https://nptel.ac.in/courses/117105135

Mapping - Course Outcomes with Program outcomes & Program-Specific outcomes

	Program outcomes												Program-specific outcomes		
20EC734	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2	2	3
CO2		3									2		2	3	3
CO3			3								2		2	3	3
CO4	3	3	3	3	3	2		3	3	3	3	2	3	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Advanced computer Networks	***Course Code: 20EC735***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Fundamentals of computer Networks.

Course Objective: This course provides a comprehensive overview on advanced topics in network protocols and networked systems. The course will cover topics related to Internet protocols and recent research results. It will examine a wide range of topics, e.g., routing, congestion control, network architectures, datacenter networks, network virtualization, software-defined networking, and programmable networks, with an emphasize on core networking concepts and principles.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the effective communication mechanisms using techniques like connection establishment, queuing theory, recovery and various congestion control techniques.
CO2:	Conceptualize on data and control plane separation, Openflow, network programmability, virtualization, data center constructs and SDN Framework.
CO3:	Analyze paradigm shift in the functionality of network models, controllers and
CO4:	Assess the strategies used for development of software defined operations and infrastructure.

Unit No.	Course Content	No. of Hours
1	**End-to-End Protocols:** Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.	**08**
2	**Congestion Control and Resource Allocation:** Congestion-Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance. The Domain Name System (DNS), Electronic Mail (SMTP,POP,IMAP,MIME), World Wide Web (HTTP), Network Management (SNMP).	**08**
3	**SDN:**Control plane, Data plane, moving information between planes, Why can separation be important? Distributed control planes: IP and MPLS, Creating the IP underlay, Convergence time, Load balancing, High availability, Creating the MPLS overlay, Replication. Centralized control planes: Logical versus Literal, Route servers. **OpenFlow:** Wire protocol, Replication, FAWG, Config and Extensibility, Architecture, Hybrid approaches: Ships in the night, SDN Controllers: General concepts-VMware.	**08**
4	**Network Programmability:** Management interface, Application-Network divide: Command line interface, NETCONF & NETMOD, SNMP, Modern programmatic interfaces: Publish and Subscribe interfaces, XMPP, Modern orchestration: Openstack.	**08**
5	**Network Function Virtualization:** Virtualization and data plane I/O, Services engineered path, Service locations and chaining: Metadata, NFV at ETSI, Non-ETSI NFV Work: Middlebox studies. SDN solutions for the data center network, Building an SDN Framework: Open Daylight Controller/Framework.	**07**

Text Books:

1. **Larry Peterson and Bruce S Davis,** *"Computer Networks:A System Approach"*,Elsevier, 5th Edition, 2014.
2. **Thomas D. Nadeau, Ken Gray, "***SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies*", O'Reilly Media Publishers, 2013.

Reference Books:

1. **Uyless Black**, "*Computer Networks, Protocols, Standards and Interfaces*" PHI.
2. **Paul Goransson, Chuck Black and Timothy Culver,**"*Software Defined Networks: A Comprehensive Approach*", Morgan Kaufmann, 2nd Edition, 2016.
3. **William Stallings**, "*Foundations of Modern Networking*", Pearson, 2016.
4. **Jim Doherty**, "*SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization*", Addison Wesley, 2016.

Web Resources:

1. https://www.youtube.com/watch?v=f5ksLu5Xjnk&list=PLG9aCp4uE-s3Mmbn4q5J87OriIN3CuFDS

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC735	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**3**											**3**
CO2	**3**	**3**	**3**											**2**	**3**
CO3	**3**	**3**	**3**											**2**	**3**
CO4	**3**	**3**	**3**	**3**										**2**	**3**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Deep Learning for computer vision	*Course Code: 20EC736*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Professional Elective course*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts of Linear Algebra.

Course Objective: To make the students understand about deep learning network models used in training, testing and validating the data, different architectures of the deep learning and various transfer learning approaches

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain multilayered neural network using various perceptron algorithms.
CO2:	Interpret the various deep learning networks involved in structuring the model and tuning of hyper parameters.
CO3:	Analyze among the different CNN and Advanced CNN Architectures.
CO4:	Validate the knowledge of deep learning for advanced CNN with different transfer learning approaches using EDA tool.

Unit No.	Course Content	No. of Hours
1	**Deep Learning and Neural Network:** Perceptron, Multi-layer perceptron, Activation functions, feed forward process, error function, optimization algorithms and back propagation, classification using MLP.	8
2	**Convolutional neural network:** Architecture and Components of CNN, Image classification using CNN, Over fitting and dropout layer, Convolution over colour images.	8
3	**Structuring DL projects and hyper parameter tuning:**Defining performance metrics, designing baseline model and data preparation, evaluation of model, tuning hyper parameters, optimization, regularization and batch normalization.	8
4	**Advanced CNN Architecture:**Description and comparison of LeNet-5, AlexNet, VGGNet, Inception, GoogleNet, ResNet.	8
5	**Transfer Learning and Object Detection:**Transfer learning, transfer learning approaches, open-source datasets, R-CNN, SSD and YOLOs.	7

SLE: Train an SSD network in a self-driving car application.

Text Books:

1. **Josh Patterson and Adam Gibson,**"Deep Learning, A practitioner's approach"O'Reily Media Inc., 1st Edition, 2017.
2. **Seth Weidman,**"Deep Learning from Scratch, Building with Python from first principles", O'Reily Media Inc., ISBN: 9781492041412, September 2019.
3. **Mohammed Elgandy,** "Deep Learning for Vision Systems", Manning Publication, 2020.

Reference Books:

1. **Luca Pietro, Giovanni Antiga, Thomas Viehmann, Eli Stevens,**"Deep Learning with PyTorch", Manning Publications, ISBN: 9781617295263, July 2020.

2. **Ian Goodfellow, Yoshua Bengio, Aaron Courville**, "Deep Learning",The MIT Press, November 2016.

Web Resources:

1. https://nptel.ac.in/courses/106106224
2. https://nptel.ac.in/courses/106105215

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC736	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3												2	
CO3			3											3	3
CO4	3	3	3	2	3										3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: SWAYAM / NPTEL Certified Course (*Professional elective-IV*)	***Course Code: 20EC737***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Certified Course	***Category: Professional Elective – IV****
CIE Marks: 50	***SEE Marks: 100***

About Course:

SWAYAM MOOCs platform is World's Largest Online Free E-Learning Platform Portal designed to achieve the three cardinal principles of Education Policy viz., Access, Equity and Quality by covering School/Vocational, Under-Graduate, Post Graduate, Engineering and Other Professional Courses.

UGC has already issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer.

Objectives:

Awareness of students of Massive Open Online Courses (MOOCs). As the (UGC -Credit Framework for Online Learning Courses through SWAYAM Regulation, 2016) enables regular students to earn credits for SWAYAM Courses, it is imperative that students are aware of these courses and access these courses at the right time and benefit from best teaching learning resources free of cost. Therefore, an attempt has been made in this study:

1. To find out awareness of MOOCs and SWAYAM platform among students of Commerce.
2. To assess factors influencing utilization of SWAYAM/ MOOCs by students.

Outcomes:

1. From a philosophical perspective, turning higher education into a public good, by allowing anyone to enroll in the courses.
2. MOOCs give an opportunity to connect openly on a global scale, with global learners
3. The ability to experiment with pedagogical methods on a vast scale
4. Can aid in the flipped classroom scenario, and student is required to produce the required document (certificate) as proof for earning the credits.

List of SWAYAM Courses identified by the department (for Professional Elective – IV): (Students can **complete 12 Weeks** of SWAYAM / NPTEL course/s between 3-6th Semester to claim exemption for Elective - IV)

Note: Student can take any of SWAYAM course in the following list or any other SWAYAM course after taking approval from Technical committee headed by HOD

Sl. No.	SWAYAM Course Title	No of Weeks
1	Optical Communications	12 Weeks
2	Research Methodology and Statistical Analysis	
3	Sustainability Science	
4	Advanced Engineering Mathematics	
5	Electric Vehicles and Renewable Energy	
6	Integrated Photonics Devices and Circuits	
7	Linux Bash	
8	Linux Operating System	
9	SCILAB	
10	Introduction to Photonics	
11	Integrated Photonics Devices and Circuits	
12	Introduction to Medical Imaging Systems	
13	Integrated Circuits, MOSFETS, Op-amps and their Applications	
14	Applied Electromagnetics for Engineers	
15	Fabrication Techniques for MEMS based Sensors	
16	Linear Systems	
17	Mathematical Aspects of Biomedical Electronics	
18	Academic Research & Report Writing	8 Weeks
19	Power Quality Improvement Technique	
20	Robotics and Control : Theory and Practice	
21	A brief course on Superconductivity	4 Weeks
22	A brief introduction of Micro - Sensors	
23	C Programming and Assembly Language	
24	Introduction to probability and Statistics	
25	Patent Drafting for Beginners	

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC737	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	0	0	0	3	3	3	0	3	2	0	0	0	0
CO2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
CO3	0	0	0	0	0	0	3	0	3	0	0	0	3	0	0
CO4	0	0	0	3	0	0	0	0	0	0	3	0	3	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Project Work Phase - 1	*Course Code: 20EC76P*
Credits: 2	*Total Contact Hours (L:T:P): 0:0:4*
Type of Course: Project	*Category: Project Work*
CIE Marks: 50	*SEE Marks: -*

Course Objective: To allow students to demonstrate a wide range of the skills learned during their course of study by asking them to deliver a product that has passed through the design, analysis, testing and evaluation and to encourage multidisciplinary research through the integration learned in a number of courses.

Course Outcome:

CO1:	Able to identify and formulate a problem through adequate literature survey, taking into consideration, societal, environmental and sustainability issues.
CO2:	Able to plan and schedule the execution of the problem by carrying out necessary design, anticipating bottlenecks and conforming to feasibility and budgetary aspects.
CO3:	Submit a synopsis and an effective presentation.

EVALUATION – 1

CO's covered

Max marks = 20

Course Outcome 1: Able to identify and formulate a problem through adequate literature survey, taking into consideration, societal, environmental and sustainability issues.

Sl. No.	Parameters	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)	M1	M2	M3	M4
1	**Problem formulation , analysis and design**	The project idea is based on extensive knowledge and literature survey by integrating major and minor concepts, the proposal also demonstrated evidence of extensive research effort and analysis.	The project idea is based on adequate knowledge and literature survey by integrating major and minor concepts The proposal also demonstrated evidence of adequate research effort and analysis.	The project idea is based on moderate knowledge and literature survey by integrating major and minor concepts. The proposal also demonstrated evidence of moderate research effort and analysis.	The project idea is based on inadequate knowledge and literature survey without proper integration of major and minor concepts. The proposal has limited research effort and analysis				
2	**Relevance of the problem**	The project idea takes an excellent account of environmenta l, societal and sustainability	The project idea takes adequate account of environmenta l, societal and sustainability	The project idea takes a moderate account of environmenta l, societal and sustainability	The project idea does not take into account environmenta l, societal and sustainability				

		issues in the identification and formulation of the problem	issues in the identification and formulation of the problem	issues in the identification and formulation of the problem, with a scope for improvement	issues in the identification and formulation of the problem. Needs reformulation				
3	**Ethical and Societal issues**	The team members exhibit very high order of ethical conduct and practices.	The team members exhibit high order of ethical conduct and practices.	The team members exhibit reasonable order of ethical conduct and practices.	The team members do not demonstrate acceptable level of ethical conduct and practices.				
4	**Communication Skills**	The team members came up with an excellent and a convincing presentation of the project idea,	The team members came up with an effective and a convincing presentation of the project idea,	The team members came up with an acceptable presentation which was reasonably convincing.	The team members could not give an acceptable presentation which was not convincing... A repeat presentation was suggested.				
5	**Teamwork**	The team worked well together to achieve the objectives. Each member contributed in a valuable way to the project proposal. All data sources indicated a high level of mutual respect and collaboration	The team worked well together most of the time, with only a few occurrences of communication breakdown or failure to collaborate when appropriate. Members were mostly respectful of each other	The team worked reasonably well together most of the time, with a few occurrences of communication breakdown or lack of co ordination Members were generally respectful of each other	Team did not collaborate or communicate well. Some members would work independently, without regard to objectives or priorities. A lack of respect and regard was frequently noted.				
					TOTAL (Out of 20)				

EVALUATION 2

Max marks = 20 + 10 (For final synopsis)

CO 2: Able to plan and schedule the execution of the problem by carrying out necessary design, anticipating bottlenecks and conforming to feasibility and budgetary aspects.

CO3: Submit a synopsis and an effective presentation

Sl. No.	Parameters	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)	M1	M2	M3	M4
1	**Design Process**	Students present an approach which is highly creative with an extremely structured design process and implementation	Students present an approach which is creative with a structured design process and implementation	Students present an acceptable approach with a design process and implementation	Students present an approach which is not acceptable with respect design process and implementation. Needs to be re submitted.				
2	**Planning and scheduling**	Students identify , schedule and sequence all the actions and resources needed to implement the project. Their articulation is detailed and accurate	Students identify , schedule and sequence all the actions and resources needed to implement the project. Their articulation is Adequate and accurate	Students identify , schedule and sequence the actions and resources needed to implement the project , but their articulation is acceptable	Students cannot identify , schedule and sequence all the actions and resources needed to implement the project				
3	**Feasibility analysis**	Students carry out an extensive survey regarding the feasibility of the project with respect to implementation and component availability. to justify their activities	Students carry out an effective survey regarding the feasibility of the project with respect to implementation and component availability. to justify their activities	Students carry out an adequate survey regarding the feasibility of the project with respect to implementation and component availability. To justify their activities. There s a scope for fine tuning	Students have not carried out necessary survey regarding the feasibility of the project with respect to implementation and component availability, To justify their activities. They need to re-plan.				
4	**Budgetary aspects**	Students present a budgetary analysis and estimate which is highly acceptable and realistic.	Students present a budgetary analysis and estimate which is reasonably acceptable and realistic	Students present a budgetary analysis and estimate which is more or less acceptable and realistic	Students present a budgetary analysis and estimate which is not acceptable and realistic. Re estimation is suggested				
5	**Teamwork**	The team	The team	The team	Team did not				

		worked well together to achieve the objectives. Each member contributed in a valuable way to the project proposal. All data sources indicated a high level of mutual respect and collaboration	worked well together most of the time, with only a few occurrences of communication breakdown or failure to collaborate when appropriate. Members were mostly respectful of each other	worked reasonably well together most of the time, with a few occurrences of communication breakdown or lack of co ordination Members were generally respectful of each other	collaborate or communicate well. Some members would work independently, without regard to objectives or priorities. A lack of respect and regard was frequently noted.				
					TOTAL (Out of 20)				

RUBRICS FOR SYNOPSIS (EVALUATION COMMON FOR THE ENTIRE TEAM)

Sl. No.	Parameters	Excellent (5)	Good (4)	Satisfactory (3)	Poor (2)
1	**Organisation, material collection, and depth of content**	Students submit a synopsis which is highly impressive with respect to the expected parameters.	Students submit a synopsis which is impressive with respect to the expected parameters.	Students submit a synopsis which is acceptable with respect to the expected parameters.	Students submit a synopsis which is not according to expected requirements. They are asked to re0 submit
2	**Language, grammar, flow and organization of figures, tables, citations etc.**	The contents and flow in the report highly conform to the best practices followed with respect to language, tone and grammar.	The contents and flow in the report conform to the best practices followed with respect to language, tone and grammar	The contents and flow in the report are acceptable with respect language, tone and grammar	The contents and flow in the report are not acceptable with respect language, tone and grammar. Students need to re submit.
TOTAL (Out of 10)					

Sl. No.	Name	Evaluation - 1 (CO 1) Marks Scored	Attained/ Not Attained	Evaluation – 2 (CO2) Marks Scored	Attained/ Not Attained	Evaluation - 2 (CO3) - Synopsis Marks Scored	Attained/ Not Attained	% Attendance	Total Marks (50 M)
1									
2									
3									
4									

- **TARGET FOR ATTAINMENT: 85 % of the maximum marks**

Panel Members:

Sl. No	Name	Signature	Date
1.			
2.			
3.			
4.			

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC76P	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	3	3	3	3	3	0	0	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Industrial Training / Internship	***Course Code: 20EC77P***
Credits : 1	***Total Contact Hours (L:T:P): 0:0:2***
Type of Course: Theory	***Category: Professional Course***
CIE Marks: 50	***SEE Marks: --***

Course objectives:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.
2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organizational setting.
3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real-world work environment.
4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Course Outcomes: After completing this course, students should be able to:

CO1	Demonstrate the application of knowledge and skill sets acquired from the course and workplace in the assigned job function/s.
CO2	Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course.
CO3	Communicate, collaborate effectively and appropriately with different professionals in the work environment through written and oral means.
CO4	Exhibit critical thinking and problem-solving skills by analyzing underlying issue/s to challenges.
CO5	Revelation professional ethics by displaying positive disposition during internship/ industrial training.

Course Content	No. of Hours
Monitoring & Evaluation of Industrial Training / Internship The industrial training/ internship of the students will be evaluated in three stages: 1. Evaluation by Industry/company. 2. Evaluation by faculty supervisor on the basis of site visit(s) or periodic communication. 3. Evaluation through seminar presentation/viva-voce at the Institute (This evaluation can be reflected through marks assigned by Faculty Mentor). **Evaluation by Industry** The industry will evaluate the students based on the punctuality, eagerness to learn, maintenance of daily diary and skill test in addition to any remarks. Finally, Industry supervisor will evaluate overall performance of intern for 100 marks. **Monitoring/ Visit by Faculty Mentor** Faculty Mentor of the institutes should communicate with the industry point of contact about the performance of the students. **Evaluation Through Seminar Presentation/Viv voice at The Institute** The student will give a seminar based on his training report, before a course mentor.The evaluation will be based on the following criteria: o Quality of content presented. o Proper planning for presentation. o Effectiveness of presentation.	26

- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report. Seminar presentation will enable sharing knowledge & experience amongst students and build communication skills and confidence in students.

Student's Diary/Daily Log

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the student's thought process and reasoning abilities. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The daily diary may be asked to produce by the Industry Supervisor of Faculty Mentor of the student at any point of time. Thus, all interns must strictly maintain his/her diary. Daily Diary needs to be submitted to Faculty Mentor at the end of the Internship. Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Faculty Mentor immediately after the completion of the training. It may be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary/log.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

Internship/ Industrial Training Report

After completion of Internship/Industrial Training, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ FacultyMentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC77P	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	0	0	0	0	0	0	0	2	2	3	3
CO2	0	3	3	0	0	0	0	0	0	0	0	2	3	2	3
CO3	0	0	0	0	0	0	0	3	3	3	0	0	0	2	3
CO4	0	3	3	3	0	0	0	0	0	0	0	0	3	2	3
CO5	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

VIII Semester

Course Title: Automotive Electronics	***Course Code: 20EC811***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Course Objective: Understand the basics of automobile dynamics and design electronics to complement those features. Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts.

Course Outcomes: After completing this course, students should be able to:

CO1	Analyze the working of different sensors and actuators in fuel injection, ignition systems and Active / Passive safety systems.
CO2	Demonstrate, a comprehension of the roles and implementations of various bus systems used in automotive networking.
CO3	Exemplify the knowledge of basic principle of actuators and explain the mechanism of hybrid drives.
CO4	Design and demonstrate the assigned task in a group with documentation and oral presentation.

Unit No.	Course Content	No. of Hours
1	**Electrical and electronic systems in the vehicle:** Overview, Motronic-engine management system, electronic diesel control, Lighting technology, electronic stability program, Adaptive cruise control, Occupant-protection systems.	8
2	**Networking and bus systems:** Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, coupling of networks, Examples of networked vehicles. **Architecture of electronic systems & Control Units:** Overview, Vehicle system architecture. Control units: Operating conditions, Design, Data processing, Digital modules in the control unit and control unit software.	8
3	**Automotive sensors:** Basics and overview, automotive applications, Sensor market, Features of vehicle sensors, Sensor classification, Selection of Sensor and Actuators**.**	8
4	**Sensor measuring principles:** Sensors for the measurement of position, speed, rpm, acceleration, pressure, force, and torque, Flow meters, temperature sensors, **Sensor types:** Engine speed sensors, Hall phase sensors, Sensors for transmission control & wheel speed, Yaw-rate sensors, Pressure sensors, Temperature sensors, Accelerator-pedal sensors, Steering angle sensors, Position sensors, Axle sensors, Piezoelectric knock sensors, Acceleration sensors, Force & torque sensors, Rain/light sensors.	8
5	**Actuators:** Electromechanical & fluid mechanical actuators, Electrical machines **Hybrid drives:** Drive concepts, operating strategies for electric hybrid vehicles, Recuperative brake system, Electrical energy accumulators.	7

SLE: Advanced engine management technologies – Artificial intelligence and Neural computing. Connected cars, central electrical control.Advanced instrumentation technology – holography, telemetry, telematics, LVDT, Dynamic vehicle position sensor, optical sensor, light sensor.
Wireless EV charging, advanced electric vehicle technology.

Text Books:

1. **Robert Bosch GmbH,** *"Bosch Automotive Electrics and Automotive Electronics"*, 5th Edition, Springer Vieweg, 2014.
2. **William B. Ribbens,***"Understanding Automotive Electronics: An Engineering Perspective"*, 8thEdition, Elsevier, 2017

Reference Books:

1. **K. Babu,***"Automotive Electrical and Electronics"*, Khanna Publishers, 1st Edition, 2018.
2. **John F. Kershaw, Ed.D. and James D. Halderman,***"Automotive Electrical and Electronic Systems"*,5th Edition, Pearson Prentice Hall, 2007.
3. **Barry Hollembeak,***"Automotive Electricity and Electronics"*, Cengage Learning, 6th Edition, 2014.

Web Resources:

1. https://www.youtube.com/playlist?list=PLCBA3EF828DFE7B0E
2. https://www.youtube.com/watch?v=STDlCdZnIsw&list=PLE06CAA834360BB39

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Programspecificoutcomes		
20EC811	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
CO4	0	0	0	0	0	0	0	3	3	3	0	0	2	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Cloud Computing	***Course Code: 20EC812***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Fundamentals of Computer Networks.

Course Objective: Student will be able to know how to provide easy, scalable access to computing resources and IT services.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamental knowledge on principles of cloud computing and its related Concepts.
CO2:	Validate virtualization technologies along with the architectural models of cloud computing.
CO3:	Apply suitable applications to leverage the strength of cloud computing.
CO4:	Demonstrate different features of cloud platforms used in Industry.

Unit No.	Course Content	No. of Hours
1	**Cloud Computing Overview:** The Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Architecture, Characteristics and Benefits, Challenges in the cloud, Historical Developments, Distributed Systems, Virtualization, Web 20, Service Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development, Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Forcecom and Salesforcecom.	**08**
2	**Virtualization:**Introduction, Characteristics of virtualized environments, Increased security, Managed execution, Portability, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples- Xen par virtualization, VMware: full virtualization, Microsoft Hyper-V. Cloud Computing Architecture: Introduction, Reference model Architecture, Infrastructure- and hardware-as-a-service, Platform as a service, Software as a service, Deployment Model-Public clouds, Private clouds, Hybrid clouds, Community clouds, Open challenges.	**08**
3	**Cloud Management:** Service Level Agreement, Cloud Economics, Managing Data, Introduction to Map Reduce, Open Stack, Resource Management.	**08**
4	**Cloud Platforms in Industry:** Amazon web services: Compute services, Storage services, Communication services, Additional services. Google Cloud, AppEngine: Architecture and core concepts, Application life cycle, Cost model Observations Microsoft Azure: Azure core concepts, SQL Azure, Windows Azure platform appliance, Observations	**08**
5	**Advanced Topic in Cloud Computing:** Green cloud computing , Introduction to Docker Container, Sensor Cloud Computing, IoT Cloud, Fog Computing, Mobile Cloud Computing	**07**

Text Books:

1. **RajkumarBuyya, James Broberg, Andrzej M. Goscinski,**"*Cloud Computing: Principles and Paradigms*", Wiley, 2011.
2. **Gautam Shroff,** "*Enterprise Cloud Computing - Technology, Architecture, Applications*", Cambridge University Press, 2010.
3. **Barrie Sosinsky,** "*Cloud Computing Bible*", Wiley-India, 2010.

Reference Books:

1. **Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski,** "*Cloud computing: Principles and paradigms*", John Wiley & Sons, 2010.

Web Resources:

1. https://nptel.ac.in/courses/106105167

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC812	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
CO3	2	2	3	3	0	0	0	0	0	0	0	0	0	0	3
CO4	3	3	3	0	3	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Digital Compression Techniques	***Course Code: 20EC813***
Credits (L: T:P): 3:0:0	***Total Contact Hours: 39:0:0***
Type of Course: Lecture	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of information theory and coding, matrix representation of audio and image

Course Objectives: To study the image fundamentals and mathematical transforms necessary for image processing, to study the image enhancement techniques, to study image restoration procedures, to study the image compression procedures.

Course Outcomes: After completing this course, students should be able to:

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CO1:	Explain on fundamental concepts of information theory for both lossless and lossy compression with mathematical models and coding techniques.
CO2:	Apply coding techniques like Huffman, Adaptive Huffman and Arithmetic coding, static and dynamic dictionary techniques for lossless compression.
CO3:	Validate compression techniques like Scalar, Vector quantization, Transform coding such as DCT, DFT and Wavelets for Lossy compression Techniques
CO4:	Demonstrate abilities in oral/ written communication and in collaborative learning.

Unit No.	Course Content	No. of Hours
1	**Introduction to data compression:** Lossless compression, Lossy compression, Modeling and coding, Brief review of information theory, Mathematical preliminaries for lossless compression, Minimum description length principle, physical, probabilistic, Markov models. Mathematical preliminaries for Lossy Compression techniques, Models: physical, probabilistic, linear system models. Distortion criteria, conditional entropy, differential entropy,	8
2	**Coding Techniques:** Huffman coding, Construction of huffman Tree, Adaptive Huffman coding, Applications of Huffman coding algorithm to text and audio processing, Arithmetic coding, Generating and deciphering the tag, Comparison of Huffman coding & Arithmetic coding, Adaptive arithmatic coding	8
3	**Dictionary techniques:** Static/Adaptive dictionary techniques like LZ77/78 compression, LZW algorithm Applications to: File compression- UNIX compress, GIF image compression, JPEG, JPEG-LS lossless imagecompression techniques.	8
4	**Lossy compression Techniques:** Scalar quantization, Uniform & Adaptive quantizer, Vector Quantization, Advantages of VQ over SQ, LBG algorithm. Transform coding: Quantization and coding of transform coefficients, DCT DFT and KLT	8
5	**Sub-band Coding:** Sub-bandcoding, analysis and synthesis filters, decimation, interpolation. Wavelets: Multi-resolution analysis and scaling function, implementation using filters, image compression using wavelets, Haar wavelet, lossy encoding using EZW and SPHIT, JPEG 2000.	7

SLE: VideoCoding I: MPEG-1 and 2 MPEG, Video Coding II: MPEG-4 and 7-Motion estimation and compensation techniques-H.261 Standard-DVI technology-PLV performance-DVI real time compression-Packet Video.

Text Books:

1. **Khalid Sayood**"*Introduction to Data Compression*", 4th Edition, Elsevier Inc, 2012.
2. **David Solomon, Giovanni Motta**"*Handbook of Data Compression*", 5th Edition, Springer, 2010.

Reference Book:

1. **Yun Q.Shi, Huifang Sun "***Image and Video Compression for MultimediaEngineering Fundamentals, Algorithms and Standards"*, CRC press, 2003.
2. **Jean-Loup Gailly Mark Nelson**, "*The Data Compression Book"* BPB PublicationsISBN-132010

Web Resources:

1. https://www.youtube.com/watch?v=5wRPin4oxCo
2. https://www.youtube.com/watch?v=rC16fhvXZOo

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

20EC813	Program Outcomes								Program Specific Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	0	0	0	0	3	0
CO2	3	2	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	3	2	0	0	0	0	0	0	0	0	0	0	0	3	0
CO4	3	3	3	0	2	0	0	0	2	2	0	2	0	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Advanced Embedded System	***Course Code: 20EC814***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course-V***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basics of Electronics

Course Objectives: The objective of this course is to equip the students with the advanced concepts of embedded system, applications in which they are used, and various aspects of embedded system design. To look closely into the Hardware and Software points of view and it describes tools and methodologies needed for embedded system design. It provides RTOS concepts for coding the embedded system software routines. It tells what makes a system a real-time system and describes the characteristics of latency in real-time systems

Course Outcomes: After completing this course, students should be able to:

CO1	Analyze the major components that constitute an embedded system.
CO2	Demonstrate the knowledge about the hardware, software structures and evaluate them for embedded systems applications.
CO3	Apply contemporary techniques for Hardware-Software co-design approach for embedded hardware and RTOS firmware development.
CO4	Design real time embedded systems using the concepts of RTOS, simulate using modern software tools through group project and give effective oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	Embedded System, Applications and Characteristics of Embedded Systems, Overview of Processor and Hardware Units in Embedded System, Embedded Software into A System, Embedded System Design, Embedded System Architecture, System on Chip, Network on Chip.	8
2	Embedded Hardware Design and Development, Sensors, A/D – D/A Converters and Actuators, Interfacing Techniques, Network Embedded Systems, Interfacing SRAM, DRAM and Flash Memory, Internet Enabled Systems – Network Protocols.	8
3	Internet Connectivity and IoT Computing, EDGE Computing Architecture and Application Areas, IoT Communication Module Protocols, Rapid Prototype Designing Using Open-Source Boards, EDGE AI and Cloud AI, Embedded AI Applications.	8
4	RTOS: Some Important Concepts, Types of Real Time Tasks and Their Characteristics, Task Scheduling, Commercial RTOS And Time Services, Features Of RTOS, Device Drivers, Interrupts and Servicing Mechanism, Interrupt Latency and Deadline, Direct Memory Access, Device Driver Programming.	8
5	Programming Model Concepts, UML 2.0 Modelling, State Charts, General C Language Characteristics, Hardware/Software Co-Design, Hardware/Software Partitioning, Testing Embedded Systems, Design for Testability and Self-Test.	7

Text Books:

1. **Raj Kamal:** "Embedded *Systems*", 4th Edition, TMH, August, 2020.
2. **Shibu K V:** "*Introduction to Embedded Systems"*, 2nd Edition, TMH, 2017.

Reference Books:

1. **James K Peckol:** "*Embedded Systems- A Contemporary Tool*", 2nd edition, John Wiley, May, 2019.
2. **Elecia White**, "*Making Embedded Systems: Design Patterns for Great Software*", O'Reilly Media; 1st edition, December 6, 2011.
3. **Yifeng Zhu,** "*Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C*", 3rd Edition, E-Man Press LLC, July 1, 2017.
4. **Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian,** "*Computer Organization and Embedded Systems"*, 6th Edition, McGraw Hill, January 27, 2011.

Web Resources:

1. https://nptel.ac.in/courses/108102045/
2. https://nptel.ac.in/courses/106105193/
3. https://nptel.ac.in/courses/106105159/
4. https://www.udemy.com/topic/embedded-systems/
5. https://www.coursera.org/courses?query=embedded%20systems
6. https://www.classcentral.com/tag/embedded-systems
7. https://www.edx.org/learn/embedded-systems
8. https://www.online.colostate.edu/certificates/embedded-systems-certificate/
9. https://www.udacity.com/course/embedded-systems--ud169

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC814	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3												3	
CO3			3												3
CO4								3	3	3			2	2	

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Operations Research	***Course Code: 20EC815***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Course objectives: The student will try to learn

Operation research models using optimization techniques based on the fundamentals of engineering mathematics. The problem formulation by using linear, inventory, game theory, queuing models and network optimization techniques.

Pre-requisite: Student should be familiar with basic concepts of algebra and matrix operations.

CO1:	Describe the different models of linear programming techniques.
CO2:	Apply the various methods and models for optimization.
CO3:	Analyze and solve different models and techniques for real world applications.
CO4:	Demonstrate the skill sets to simulate/ analysis tools to solve engineering and business problems.

Unit No.	Course Content	No. of Hours
1	**Linear models:** The phase of an Operation Research study, introduction to Linear Programming assumptions, graphical method, simplex algorithm, duality formulation, dual simplex, bit-integer programming (BIP), upper bound and interior point algorithms.	8
2	**Transportation and network optimization models:** Transportation and assignment Models, Traveling Salesman Problem, Networks Models, Shortest Route, Minimal Spanning Tree, Maximum Flow Models, Project Network, Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT) Networks.	8
3	**Inventory models:** Economic Order Quantity Models, Quantity Discount Models, Stochastic Inventory Models, Multi Product Models, Inventory Control Models in real time applications and practice.	8
4	**Queuing models:** Introduction to Queuing Systems and Structures, Notation Parameter, Single Server and Multi Server Models, Poisson Input, Exponential Service, Constant Rate Service, Infinite Population, Problems and applications.	8
5	**Decision models:** Game Theory, Solving simple game problems, Two Person Zero Sum Games, Graphical Solution, Algebraic Solution, Linear Programming Solution. Replacement Models, Models Based On Service and Economic Life, Single or Multi Variable Search Technique and Simple Problems.	7

SLE: Parametric algorithm, Critical Path Scheduling technique. Case study on inventory model, Simulation and Dynamic Programming.

Text Books:

1. **Hiller and Lieberman**, *"Introduction to Operations Research"*,10th Edition, TMH publications, Reprint 2017.
2. **R. Pannerselvam,** *"Operations Research"*, 2nd Edition, PHI publications, 2006.

Reference Books:

1. **HamdyTaha,***"Operations Research"*, 8th Edition, TMH publications, 2001.

Web Resources:

1. https://nptel.ac.in/courses/112106134/
2. https://youtu.be/lRpt1fCHd8Y?list=PLCmoXVuSEVHlEJi3SwdyJ4EICffuyqpjk
3. https://youtu.be/o9vEnzLL-lY?list=PLojsqdbIzJGQtub91c4fF-TcCdzVYAInM

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC815	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	2	2	2
CO4	0	0	0	0	3	3	2	2	3	2	2	2	2	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Low Power VLSI Design	***Course Code: 20EC821***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basics of Electronics, CMOS VLSI Circuit.

Course Objective: Learn how to increase the battery life of portable devices, leakage and dynamic power reduction is emerging as a primary goal of the VLSI circuit design.

Course Outcomes: After completing this course, students should be able to:

CO1	Explain the need of Low power circuit design and the knowledge of architectural approaches
CO2	Analyze the power of Low power Architecture & Systems with necessary clock distributions.
CO3	Demonstrate the simulation of Low power Architecture & Systems using EDA tool.

Unit No.	Course Content	No. of Hours
1	Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing& gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.	8
2	**Simulation Power analysis:** SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. **Probabilistic power analysis**: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library.	8
3	**Logic level:** Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. **Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components.	8
4	**Low power Clock Distribution:** Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network.	8
5	**Special Techniques:** Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.	7

Text Books:

1. **Gary K. Yeap**, "*Practical Low Power Digital VLSI Design*", KAP, 2002
2. **Rabaey, Pedram,** "*Low Power Design Methodologies*" Kluwer Academic, 2010.

Reference Books:

1. **Kaushik Roy, Sharat Prasad**, "**Low-Power CMOS VLSI Circuit Design**" Wiley, 2000
2. **Yeo**, "*CMOS/BiCMOS ULSI Low Voltage Low Power*" Pearson Education, 2005

Web Resources:

1. https://www.youtube.com/watch?v=ruClwamT-R0&list=PLTEh-62_zAfHmJE-pcjgREKiKyPSgjkxj
2. https://www.youtube.com/watch?v=K2kL7pMnL_0&list=PLVDb88QIgXkeeUo6I2oudLvc76GbLGrTi

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC821	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Mobile Computing	***Course Code: 20EC822***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective Course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basics of Mobile Communication.

Course Objectives: This course will examine the area of wireless networking and mobile computing, looking at the unique network protocol challenges and opportunities presented by wireless communications and host or router mobility. The course will give a brief overview of fundamental concepts in mobile wireless systems and mobile computing.

Course Outcomes: After completing this course, students should be able to:

CO1	Explain the evolution of wireless and mobile communication networks with respect to their technical features and applications
CO2	Analyze the fundamental concepts of mobile computing and identify the challenges related to mobile operating systems.
CO3	Evaluate the different inter-networking challenges and Wireless Application Protocol (WAP) for Internet access
CO4	Simulate real time computing problems using modern software tools through group projects and give oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	Principle of Cellular Communication, Overview 1G, 2G, 2.5G, 3G,4G and 5G technologies. Mobile Computing fundamentals. Mobile Devices and mobile OS - Palm OS, Win CE, Symbian, Android and iOS. Security issues in mobile computing.	8
2	Data perspective: CDPD, GSM Architecture and data services, CDMA, 3G, 4G,5G, VoIP, Wireless Local Loop (WLL) system, Wireless Telephony	8
3	Mobile IP and IP v 6 and its application in mobile computing. Wireless Application Protocol (WAP): The Wireless Application Protocol application environment, wireless application protocol client software, hardware and websites, wireless application protocol gateways, implementing enterprise wireless application protocol.	8
4	An Introduction to WML and XML, key XML technologies for mobile computing, Writing and Formatting Text, navigating between Cards and Decks, Displaying Images, Tables, Using Variables, Acquiring User Input. UML and XForms.	8
5	Introduction to mobile development process. Architecture, design and technology selection for mobile application. Mobile application development hurdles. Testing mobile applications.	7

Text Books:

1. Raj Kamal: “Mobile Computing”, Second Edition, Oxford University Press,2013
2. Ashoke K Talukder, Hasan Ahmed and Roopa R Yavagal: “Mobile Computing”, Second Edition, Tata McGraw Hill, 2010.

Reference Books:

1. Yi Bing Lin and ImrichChlamtac: “Wireless and Mobile Networks Architecture”,Third Edition, John Wiley,2008
2. Uwe Hansmann, Lothar Merk, Mertin S Nickloue and Thomas Stober: “Principles of Mobile Computing” Second Edition, Springer International Edition, Springer Professional Computing, 2003.

Web Resources:

1. https://www.youtube.com/watch?v=5MoIg5lWLXA
2. https://www.youtube.com/watch?v=Rjluns-AEnc
3. https://www.youtube.com/watch?v=oxTUC5I22LU&list=PLE6yE0jB6BTMJXIXw4PS1kOqqZ9ty7eoG
4. https://www.youtube.com/watch?v=uIPtLr8R1-U&list=PLE6yE0jB6BTOY6Z1DKEkQ8yZ8fFPUiCD8

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC822	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
CO4	0	0	0	0	0	0	0	3	3	3	0	0	2	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Assistive Technology	***Course Code: 20EC823***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basics of Electronics and Communication technologies.

Course Objectives: This course explores the types and uses of assistive technology. Students compare technologies related to vision, hearing, communication, mobility, and cognitive disabilities. Projects enable students to evaluate the needs of people with disabilities and the community resources, funding sources, and systems available to increase their independence.

Course Outcomes: After completing this course, students should be able to:

CO1:	Understand principles and complexities of assistive technology design and engineering.
CO2:	Explain the challenges and realities of people with disabilities and become equipped as an advocate.
CO3:	Analyze the design experience that includes working with users of assistive technology to identify challenges, prototype solutions, perform user testing, and communicate results.
CO4:	Provide an opportunity for students to interact with users of assistive technology in the local community along with health care professionals, coaches, and project partners

Unit No.	Course Content	No. of Hours
1	**Introduction**: Assistive and adaptive rehabilitation devices for people with disabilities. **Use case**: Assistive technology for improving the quality of life, for people with acquired brain injury, for the with communication disorder and with visual impairment & behavioral problem. (T1)	08
2	**Assistive devices**: Mobility aids such as wheel chair, tri cycle, walkers, prosthetic device. Hearing aids such as behind the ear (BTE), In the ear (ITE) and In the canal (ITC) for people with hearing disabilities. **Case study** on application of Low-Cost Devices as Teaching Materials for Children with Different Disabilities.Imaging Systems in Assistive Technology (T 2)	08
3	**Technology for Assistive devices:** Mechanical Engg Support, Electrical and electronics Enggsupports and programming support. Aging, Disability, and Assistive Internet of Things**Assistive IoT**: Enhancing Human Experiences, Deployment Scenarios and Challenges. (T3)	08
4	**Industries Supports:** Ethical Issues in Assistive Technology, Delivering Assistive Technology Services to the Client, Technologies That Aid Transportation, Robotic Assistive Technologies That Aid Manipulation, Sensory Aids for Persons With Visual Impairments, Assistive Technologies for Cognitive Augmentation.	08
5	**Case studies:**Assistive Technology Based on a Psychological Model of Elderly People, Touch Screens for the Older User, Intelligent HTMLtoVoiceXML Conversion Agent for Text Disabilities, Assistive Technology for People with Communication Disorder. A Multi-Disciplinary Approach to Ambient Assisted Living. (T2) (R1)	07

Text Books:

1. **Giulio E. Lancioni, Nirbhay N. Singh,**"*Assistive Technologies for People with Diverse Abilities*", Springer, 2014.
2. **Fernando A. AuatCheein,**"*ASSISTIVE TECHNOLOGIES*", Intech,2012.
3. **Seyed Shahrestani,**"*Internet of Things and Smart Environments*", springer,2017.
4. **Albert M. Cook, Janice M. Polgar and Pedro**"Assistive Technologies, *Principles & Practice",* Elsevier, 5th Edition, 2020.

Reference Books:

1. **Carsten Rocker, Martina Ziefle,**"*E-Health, Assistive Technologies and Applications for Assisted Living*", Medical Information Science Reference, 2011.

Web Resources:

1. Text book 4 link: https://doi.org/10.1016/C2016-0-02627-X

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20ECXX	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
CO2	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**
CO3	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
CO4	**3**	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**3**	**3**

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Advanced Vehicular Network	*Course Code: 20EC824*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Professional Elective course*
CIE Marks: 50	*SEE Marks: 100*

Course Objective: To modernize the operation of vehicles, manage vehicle traffic, and assist drivers with security and other information.

Course Outcomes: After completing this course, students should be able to:

CO – 1	Explain the challenges in designing MAC and Routing protocols for wireless ad-hoc networks with fundamental concepts of vehicular ad-hoc Networks.
CO – 2	Analyze the various vehicular communication technologies used in VANET.
CO – 3	Design and evaluate message forwarding strategies, Challenges and applications in VANET.
CO - 4	Demonstrate the simulation of real time problems using modern software tools through group projects.

Unit No.	Course Content	No. of Hours
1	**Introduction to VANET:** Introduction of ad-hoc networks, Key definitions of ad-hoc networks Ad Hoc Network features, Classification, Advantages of ad-hoc/sensor networks - Unique constraints and challenges Driving Applications, Vehicular Ad Hoc Network (VANET), VANET Scenarios, Differences between VANET and MANET, need of VANET, Components of VANET, Characteristics of VANET.	8
2	**MEDIA ACCESS CONTROL (MAC) PROTOCOLS:** Media Access Control (MAC) Protocols Introduction - Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks – Classifications of MAC Protocol. MACAW – FAMA – BTMA – DPRMA – Real-Time MAC protocol – Multichannel Protocols – Power Aware MAC. **ROUTING PROTOCOLS:** Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks – Classifications of Routing Protocols -Table-driven protocols – DSDV – WRP – CGSR – On-Demand protocols – DSR – AODV – TORA – LAR – ABR – Zone Routing Protocol – Power Aware Routing protocols.	8
3	**Communication in VANET:** Types of Communication in VANET, Introduction to dedicated short range communication, IEEE 1609.0(WAVE Architecture), IEEE 1609.1(Network Resources Management), IEEE 1609.2 (Security Services), IEEE 802.11P(Physical layer), IEEE 802.11P(MAC Layer) and IEEE 1609.3(Networking Services)	8
4	**Message forwarding strategies in VANET and Challenges in VANET:** Introduction, types of messages in VANET, Message forwarding strategies, Message packet format, need of priority-based message forwarding, proposed priority assigning mechanism and analysis of priority-based message delivery, Volatility, Critical time latency of message delivery, Drastic increment in vehicles and roads, Diverse networking standards, High mobility of Nodes, Network security, Efficient Message forwarding and Mitigation techniques to address VANET security.	8
5	Scope and Application of VANET: Scope of VANET, Road traffic management services, commercial application services, road safety services, Application of VANET: Road safety, real timing traffic monitoring, cooperative message	7

	exchange, priority-based messaging, collision avoidance messages, lane guidance, emergency notifications, E-toll collections prediction services.	

Text Books:

1. **Sonali P.Botkar, Sachin P.Godse, Parikshit N.Mahalle and Gitanjali R.Shinde**, "VANET: Challenges and Opportunities", First edition, CRC Press, Taylor and Francis group, 2021.
2. **C. Siva Ram Murthy and B. S. Manoj**, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2004.

Reference Books:

1. **Hannes Hartenstein and Kenneth P Laberteaux,**"VANET: Vehicular Applications and Inter-Networking Technologies", First edition, A John Wiley and Sons, Ltd, Publication, 2010.
2. **Claudia Campolo, Antonella Molinaro and Riccardo Scopigno**, "Vehicular ad hoc Networks: Standards, Solutions, and Research", Springer International Publishing Switzerland, 2015.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC824	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	0	3	0	0	3	3	3	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Optical Networks and sensors	***Course Code: 20EC825***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Professional Elective course***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with Basics of Optical Fiber Communication and Fundamentals of Computer Network

Course Objectives: To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Course Outcomes: After completing this course, students should be able to:

CO – 1	Classify and comprehend the working of optical networks with different parameters.
CO – 2	Illustrate the networking aspects involved in optical fiber along with the operation associated with it.
CO – 3	Design the constructional features and the characteristics of Packet switching.
CO - 4	Analyse the construction and working principle of WDM Network Design for various models.

Unit No.	Course Content	No. of Hours
1	Evolution of optical networks architecture: Introduction, Optical networks architecture, Long-haul optical networks, Regional/metro optical networks, Optical access networks, All-optical networks — the wave of the future	8
2	Photonic Packet Switching: Optical Time Division Multiplexing, Tunable Delays, Optical Phase Lock Loop, Buffering, Burst Switching	8
3	WDM Network Design: LTD and RWA Problems, Dimensioning Wavelength-Routing Networks, Statistical Dimensioning Models, Maximum Load Dimensioning Models	8
4	Design aspects of optical communication networks: Introduction, Optical networking and wavelength-division multiplexing, Control and management of WDM networks, Need for a design tool, Design architecture, Applications of ARTHUR	8
5	Emerging optical network management: Third-generation network management goals, Generic framing procedure, Optical transport network, Generalized multi-protocol label switching, Protocols for bandwidth managementin third-generation networks, Protocols for lightpath establishment and management.	7

Reference Books:

1. **Rajiv Ramaswami and Kumar Sivarajan**, "*Optical Networks: A practical perspective*", 3rd edition, Morgan Kaufmann, 2009.
2. **Partha Pratim Sahu**, "*Advances in Optical Networks and Components*", CRC Press, 2020.
3. **Milorad Cvijetic, Ivan B Djordjevic,** "*Advanced Optical Communication Systems and Networks*", 1st Edition, Artech House Publishers, 2012.
4. **Mohammad Ilyas, Hussein T. Mouftah**, "*The handbook of optical communication networks*", CRC Press, 2019

Web Resources:

1. https://nptel.ac.in/courses/117104127.
2. https://www.coursera.org/lecture/computer-networking/fiber-connections-DG82X.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC825	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO4	2	2	0	0	0	0	0	0	0	0	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Project work Phase - 2	***Course Code: 20EC83P***
Credits: 10	***Total Contact Hours (L:T:P): 0:0:20***
*******Since most of the students are doing their project work and internship in industries, they will be working under industry guide for 6 hours a day which amounts to 30 contact hours per week (Monday to Friday), along with this they are also meeting their academic guides on Saturdays or any other convenient day for 3hours.* *Those who are working for their project in the college will be in regular contact with their academic guides on all working days.*	
Type of Course: Project	***Category: Project Work***
CIE Marks: 70	***SEE Marks: 30***

Course Objectives: To allow students to develop problem solving, analysis, synthesis and evaluation skills, to encourage teamwork and to improve students' communication skills by asking them to produce both a professional report and to give an oral presentation.

Course Outcome Covered:

CO1:	Function effectively in a team contributing constructively for implementation and successful completion of the project with an efficient management of time and resource.
CO2:	Fabricate/implement the project adopting necessary tools and techniques adhering to ethical issues and carry out a performance evaluation based on prevailing trends.
CO3:	Demonstrate the working of the project and lifelong learning attitude by validating the results of the work to meet futuristic trends, sustainability aspects and publication requirements.
CO4:	Prepare a comprehensive document and give an effective presentation making use of modern tools, adhering to standard practices and ethics.

PHASE	PARAMETERS FOR EVALUATION	M1	Total	M2	Total	M3	Total	M4	Total
Phase 1 (15 Marks)	1. Presentation of the problem **(04 M)**								
	2. Clarity and concepts **(04 M)**								
	3. Innovative approach **(03 M)**								
	4. Scheduling the work and adherence **(04 M)**								
Phase 2 (15 Marks)	1. Progress as per schedule **(05 M)**								
	2. Fabrication details and status **(05 M)**								
	3. Presentation and intermediate results **(05 M)**								
Phase 3 (25 Marks)	1. Demonstration of working **(10 M)**								
	2. Completion of the work **(04 M)**								
	3. Presentation of the work **(04 M)**								
	4. Queries **(03 M)**								
	5. Innovation and application **(04 M)**								
Report (15 Marks)	1. Adhering to standard format **(05 M)**								
	2. Language and grammar **(05 M)**								
	3. Clarity in presentation organization **(05 M)**								
Total		**M1**		**M 2**		**M 3**		**M 4**	

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC561OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	0	0	0	0	0	0	3	0	0	3	3	3	3
CO2	3	3	0	3	0	0	0	3	0	0	0	0	3	3	3
CO3	0	0	0	0	0	0	3	0	0	3	3	0	0	3	3
CO4	0	0	0	0	3	0	0	3	3	3	0	0	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Open Electives
V - Semester

Course Title: CMOS VLSI Circuits	***Course Code: 20EC561OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: To learn basic CMOS Circuits, CMOS process technology, CMOS circuits that realize specified digital functions, understanding of the characteristics of CMOS circuit, apply CMOS technology-specific layout rules and be able to design CMOS combinational and sequential logic at the transistor level.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the basic MOS technology and circuit design processes.
CO2:	Express and apply the Layout of simple MOS circuit using Lambda based design rules for subsystem design.
CO3:	Analyze the CMOS Logic structures for VLSI applications with the basic circuit concepts.
CO4:	Demonstrate the simulation of CMOS logic circuits using EDA tool.

Unit No.	Course Content	No. of Hours
1	**Basic MOS Technology:** enhancement and depletion mode MOS transistors. nMOS fabrication. CMOS fabrication, MOS transistor theory Introduction, MOS device design equations, the complementary CMOS inverter-DC characteristics, static load MOS inverters.	8
2	**Circuit Design Processes**: MOS layers, stick diagrams, Design rules and layout- lambda-based design and other rules. Examples, layout diagrams, symbolic diagram, tutorial exercises. Basic physical design of simple logic gates.	8
3	**CMOS Logic Structures**: CMOS complementary logic, BiCMOS logic, Pseudo-nMOS logic, Dynamic CMOS logic, clocked CMOS logic, Pass transistor logic, CMOS domino logic cascaded voltage switch logic (CVSL).	8
4	**Basic circuit concepts**: Sheet resistance, area capacitances, capacitances calculations. The delay unit, inverter delays, driving capacitive loads, propagation delays, wiring capacitances. Scaling of MOS circuits - Scaling models and factors, limits on scaling, limits due to current density and noise	8
5	**CMOS subsystem design:** Architectural issues, switch logic, gate logic, design examples-combinational logic, clocked circuits. Other system considerations. Clocking strategies. General considerations, process illustration, ALU subsystem, adders, multipliers.	7

Text Books:

1. Douglas. A. Pucknell, Kamran Eshragian: *"Basic VLSI Design,"* 3rd Edition, Eastern Economy Edition, 2005.

2. Neil H.E. Weste, David Harris, AyanBannerjee:*CMOS VLSI DESIGN: A Circuits and Systems Perspective,"* 3rd Edition, Published by Pearson Education, 2005.

Reference Books:

1. **R. Jacob, W. Li, David .E. Boyce:** "*CMOS Circuit Design, Layout, and Simulation,"* Prentice Hall India, 1998.
2. **Sung-Mo Kang, Yusuf Leblebici:** "*CMOS DIGITAL INTEGRATED CIRCUITS Analysis and Design,"* 2nd Edition, McGraw Hill, 2003.

Web Resources:

1 https://youtu.be/Gv5fESGW2Ms?list=PLNhFkFk6qEgLxC8XgE38cYNgI1wldYxXZ

2 https://youtu.be/lRpt1fCHd8Y?list=PLCmoXVuSEVHlEJi3SwdyJ4EICffuyqpjk

3 https://youtu.be/o9vEnzLL-lY?list=PLojsqdbIzJGQtub91c4fF-TcCdzVYAInM

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC561OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	0	3	0	0	0	0	0	2	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Sensors and Actuators	***Course Code: 20EC562OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: This course covers topics on fundamental and applications of several different types of sensors and actuators that are extensively utilized in mechanical and agricultural systems.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamentals of Sensors and its working principle
CO2:	Analyze the type of sensor required for a particular application
CO3:	Apply the actuation principles involved in practical applications
CO4:	Demonstrate real time problems through group projects and give oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	Sensor Fundamentals: Basic Sensor Technology, Sensor Systems, Sensor Characteristics, System Characteristics, Instrument Selection, Sensor Signal Conditioning	8
2	Optical Sensors: Overview of Fibre optic sensors, luminescence based sensors, absorption based sensors, surface plasmon resonance based sensors Applications: Structural Health Monitoring Flow and Level Sensors, Methods for Measuring Flow, Strain Gage Sensors	8
3	Biosensor: Overview, Applications of Biosensors, Origin of Biosensors, Bio receptor Molecules, Transduction Mechanisms in Biosensors, Application, Range of Biosensors.	8
4	Actuators: Introduction, Functional components of an actuator, Actuator as a system component, Intelligent & Self sensing actuators, microactuation, MEMS with microactuators, piezoelectric actuators, Application examples (Automatic anti-lock braking systems).	8
5	Nanotechnology-Enabled Sensors: Possibilities, Realities, Applications. Sensor Networking IoT: Introduction, Fields Using Sensor Networking	7

Text Books:

1. **Jon S Wilson**, "*Sensor Technology handbook*", Elsevier, 2005
2. **John R. Vacca**, "*Handbook of Sensor Networking*", CRC Press, 2014.
3. **Nathan Ida:**"*Sensors, Actuators, and their Interfaces*", 2nd Edition, SciTech Publishing Inc, 2020.

Reference Books:

1. **Ignacio Del Villar**, **Ignacio R. Matias**, "*Optical Fibre Sensors: Fundamentals for Development of Optimized Devices*", Wiley Publications, 2020.
2. **Tai-Ran Hsu**: "*MEMS & Microsystems Design and Manufacture*", Tata McGraw Hill, 2007.
3. **Clarence W. de Silva,** "*Sensors and Actuators Engineering System Instrumentation*", CRC Press, 2nd Edition, 2016.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC562OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	2	2	0	0	0	0	0	0	0	1	0	0	2	0	0
CO4	2	2	0	0	0	0	0	0	0	1	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

***Course Title:* Wireless Communication**	***Course Code:* 20EC563OE**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of electronics.

Course Objective: To expose the students to understand mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards.

Course Outcomes: After completing this course, students should be able to:

CO 1:	Explain the cellular concept architecture and propagation models.
CO 2:	Apply the basic knowledge of interference and system capacity, power control and propagation models in solving and designing a cellular system.
CO 3:	Demonstrate cellular architecture, GSM roaming and handover scenarios using simulation tools.
CO 4:	Demonstrate in teams to implement assigned tasks related to advanced topics.

Unit No.	Course Content	No. of Hours
1	**Cellular Concept:** Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Power Control for Reducing Interference, Trunking and Grade of Service, Improving Capacity in Cellular Systems. **Mobile Radio Propagation:** Large Scale Path Loss- Free Space Model, three basic propagation mechanisms, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models – Okumura, Hata, PCS Extension to Hata Model.	8
2	**Mobile Radio Propagation: Small-Scale Fading and Multipath:** Small scale Multipath Propagation, Impulse Response Model of a Multipath Channel, Small-Scale Multipath Measurements, Parameters of Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distributions, Statistical Model for Multipath Fading Channels (Clarke's Model for Flat Fading only).	8
3	**System Architecture and Addressing:** System architecture, The SIM concept, Addressing, Registers and subscriber data, Location registers (HLR and VLR) Security-related registers (AUC and EIR), Subscriber data, Network interfaces and configurations. **Air Interface** – GSM Physical Layer: Logical channels, Physical channels, Synchronization- Frequency and clock synchronization, Adaptive frame synchronization, Mapping of logical onto physical channels, Radio subsystem link control, Channel coding, source coding and speech processing, Source coding and speech processing, Channel coding, Power-up scenario. **GSM Protocols:** Protocol architecture planes, Protocol architecture of the user plane, Protocol architecture of the signaling plane, Signaling at the air interface (Um), Signaling at the A and Abis interfaces, Security-related network functions, Signaling at the user interface.	8
4	**GSM Roaming Scenarios and Handover:** Mobile application part interfaces, Location registration and location update, Connection establishment and termination, Handover. **Services:** Classical GSM services, Popular GSM services: SMS and MMS. **Improved data services in GSM:** GPRS, HSCSD and EDGE GPRS System architecture of GPRS, Services, Session management, mobility management	8

	and routing, Protocol architecture, Signaling plane, Interworking with IP networks, Air interface, Authentication and ciphering, Summary of GPRS. HSCSD: Architecture, Air interface, HSCSD resource allocation and capacity issues. EDGE: The EDGE concept, EDGE physical layer, modulation and coding, EDGE: effects on the GSM system architecture, ECSD and EGPRS.	
5	**CDMA Technology** – Introduction to CDMA, CDMA frequency bands, CDMA Network and System Architecture, CDMA Channel concept, Forward Logical Channels, Reverse logical Channels, CDMA frame format, CDMA System Operations(Initialization/Registration), Call Establishment, CDMA Call handoff, IS-95B, CDMA2000, W-CDMA, UMTS,CDMA data networks, Evolution of CDMA to 3G, CDMA 2000 RAN Components, CDMA 2000 Packet Data Service.	7

Text Books:

1. **Theodore S Rapport**, "*Wireless Communications – Principles and Practice*", Prentice Hall of India, 2nd Edition, 2007, ISBN 978-8-120-32381-0.
2. **Jorg Eberspacher, Hans-Jorg Vogel, Christian Bettstetter, Christian Hartmann**, "*GSM–Architecture, Protocols and Services*", Wiley,3rd Edition, 2009, ISBN-978- 0-470-03070-7.

References:

1. **W.C.Y. Lee,** "*Mobile Cellular Communications*", 2nd Edition, MC Graw Hill, 1995.
2. **Yi-Bing Lin,** "*Wireless and Mobile Netwok Architecture*", 2nd Edition, Wiley publications 2008.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC563OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0	0	0	2	0	3	0
CO3	3	3	0	0	0	0	0	0	0	0	0	0	2	3	3
CO4	0	0	0	3	0	3	0	0	3	0	0	3	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Control Systems	***Course Code: 20EC564OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Signals and Systems, Engineering Mathematics

Course Objectives: To understand concepts of the mathematical modeling, feedback control and stability analysis in Time and Frequency domains Basic Concepts: Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems, Linear and non-linear systems, Transfer function.

Course Outcomes: After completing this course, students should be able to:

CO1:	Represent physical systems as mathematical model.
CO2:	Analyze various properties of the control systems in time domain and frequency domain using appropriate tools.
CO3:	Design and test the controllers for transfer function models.
CO4:	Demonstrate modeling and controller design using modern tools.

Unit No.	Course Content	No. of Hours
1	S**ystem Modeling:** Basics of Signals, Systems, Fourier and Laplace transform, Concept of feedback control, transfer function modeling of mechanical, electrical and electromechanical systems, Block diagram representation and its algebra, Signal flow graphs and Mason's gain formula. **SLE:** Transfer function model of Boeing aircraft, Satellite, Power systems	**8**
2	**Time domain analysis**: Effect of pole-zero location and addition, step response and impulse response of the standard first and second order systems, BIBO stability, Routh-Hurwitz method, Steady state error analysis of Type-0,1,2 systems. **SLE:** Lyapunov's stability theorems	**8**
3	**Controller Design for TF:** Design of classical PI, PD and PID controllers, Root-locus of a basic feedback system. Rules for sketching Root-locus for simple poles-zeros; multiple poles-zeros. **SLE:**PID control design using MATLAB,	**8**
4	**Design in Frequency Domain:** Frequency response of LTI system and Bode plots, Nyquist stability criterion, stability margins, closed-loop frequency response, design of Phase lead compensator using Bode plots. **SLE:** Design of Phase-lead and lag compensator using MATLAB	**8**
5	**State-space modeling:** For mechanical, electrical and electromechanical systems, Relation between SS model and TF model, solution of state equation. **SLE:** State variable feedback, Pole placement design using SS model	**7**

Text Books:

1. **G. F. Franklin., G. D. Powell., A. E. Naeini**, "*Feedback Control of Dynamic Systems"*, Pearson Education, 5th Edition, 2002.

2. **M. Gopal**, "*Control Systems: Principles and Design"*, Tata Mc Graw Hill, 2012.

Reference Books:

1. **K. Ogata**, "*Modern Control Engineering*", 4th Edition, Pearson Education, 2006.
2. **S. K. Bhattacharya**, "*Control Systems Engineering*", Pearson Education, 2005.

Web Resources:

1. Dr. M. Gopal https://www.youtube.com/watch?v=vVFDm__CdQw
2. https://www.youtube.com/channel/UCq0imsn84ShAe9PBOFnoIrg

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC564OE	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3												3	3	
CO2		3												3	
CO3			3												3
CO4	3	3	3	3	3			3	3	3					3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Smart Materials	***Course Code: 20EC565OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-I***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts and fundamentals of mechanics of materials, physics and chemistry.

Course Objectives: The student will try to learn,

1. Various kinds of smart material used in the application of innovative technologies.
2. Design principles of smart materials as sensors and actuators.
3. Study the fabrication of smart material systems and their applications.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the functions of smart materials as sensors and actuators.
CO2:	Apply the design principles and fabrication techniques to develop smart material systems.
CO3:	Analyze the prerequisites of smart material structures in different applications.
CO4:	Demonstrate the skill sets to discuss smart materials towards applied technology.

Unit No.	Course Content	No. of Hours
1	**Introduction:** Smart Materials, smart systems, sensors, actuators, transducers, MEMS, scaling effects, evolution of smart materials, processing of smart materials, semiconductors processing, crystal growth from the melt, epitaxial growth, metallization techniques, bulk ceramics, thick and thin films, micromachining techniques, polymers and their synthesis, classification and methods.	8
2	**Design principles:** Sensors for smart systems, capacitive sensors, piezoelectric sensor, piezoresistive sensors, with design examples, Actuators for smart systems, electrostatic transducers, piezoelectric transducers and electrothermal actuators.	8
3	**MEMS silicon fabrication techniques:** Lithography, resist and mask formation, deposition techniques, lift-off technique, etching techniques, wafer bonding, metallization, thermal oxidation for SiO_2, CVD for dielectrics, polysilicon and ceramic thin film deposition. Difference between surface and bulk micromachining. LIGA Process	8
4	**MEMS polymeric** fabrication techniques: Microsteriolithography, overview, MSL by scanning methods, projection-type method, micro-injection molding, microphotomolding, micro hot-embossing, micro transfer molding, burnout and sintering, jet molding, powder injection molding, fabrication of 3-D structures, metal-polymer structures.	8
5	**Applications of smart materials:** Agriculture and food sectors, automotive industry, defence and spacesectors.	7

SLE: Synthesis of smart materials and characterization techniques.

Text Books:

1. **Vijay K Vardhan, K J Vinoy. S, Goplakrishnan,** *"Smart Material Systems and MEMS: Design and Development Methodologies"*, 1st edition, John Wiley & Sons, Inc., 2011.
2. **B.S. Murthy, P Shankar, Baldev Raj, B.B. Rath, and James Murday,** *"Textbook of Nanoscience and Nanotechnology"*, 1stedition, Universities Press, 2012.

Reference Books:

1. **Tai Ran Hsu,** *"MEMS and Micro Systems: Design and Manufacture"*, 1st edition, Tata McGraw Hill, 2002.

Web Resources:

1. https://www.sciencedirect.com/topics/chemistry/smart-material
2. https://nptel.ac.in/courses/112104173

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC565 OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	0	0	0	2	0	0	2	3	2	2	2	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Open Electives
VI - Semester

Course Title: Nanoscience and Technology	*Course Code: 20EC651OE*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective Course-II*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts and mechanicsof materials.

Course Objective:

1. To learn various forms of nanomaterials for special applications.
2. To understand various Nanostructure characterization techniques.
3. Study the principles, process steps and system components of the various lithographic techniques.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the fundamentals of nanoscience and nanotechnology.
CO2:	Apply the knowledge of nanostructures and nano materials to science and technology.
CO3:	Analyse the depositionand characterization techniquesto thin film structures.
CO4:	Demonstrate the skill sets in simulating various applications of nanoscience and nanotechnology.

Unit No.	Course Content	No. of Hours
1	**Introduction to Nanotechnology** Introduction to nanoscience and nanotechnology, current technologies, beginning, implications, nano and world societies, societal aspects, nano-economics, the rise of nanotoxicology, policy debates and public engagement.	8
2	**Anisotropic Nanomaterials** Introduction, One, Two and Three-dimensional Nanoparticles, General Strategies for the Synthesis of One-, Two- and Three-dimensional Nanostructures, Properties of Anisotropic Nanoparticles,Applications of Anisotropic Nanomaterials,One-Dimensional Nanostructures-Nanorods and Nanowires.	8
3	**Synthesis and characterization of Nanomaterials** Introduction, Synthetic Methods: Common Issues of Concern,Variety in Nanomaterials, Microemulsion-based Methods for Nanomaterials, Solvothermal Synthesis, Electron Microscopies, Optical Microscopies for Nanoscience and Technology, X-ray Diffraction, Small Angle Neutron/X-ray Scattering (SANS/SAXS), Cyclic Voltammetry, Impedance Analysis, Raman Scattering.	8
4	**Nano and molecular electronics** Silicon MOS Transistor from Micro to Nano-Introduction, Downscaling and Moore's Law, Challenges for Nano-MOSFETs, Emergence of new Materials, Novel Device Structures,Innovations in Process Technology, Dendritic nanostructures, macromolecules and dendrimers, top-down and bottom up process, molecular transport, mechanism and advanced applications.	8
5	**Applications of Nanotechnology** The NanotechnologyBusiness-Nanotechnology Statistics,The Total ,The Current Situation, Types of Nanotechnology,The Safety of Nanoproducts, Ultraprecision Engineering,Aerospace and Automotive Industries , Architecture and Construction, Catalysis, Environment, Lubricants, Metrology—Instrumentation,Minerals and Metal Extraction, Textiles,Silicon Microelectronics, Data Storage Technologies, Display Technologies, The Future of Nanotechnology.	7

SLE: Nanomaterials in energy storage, aerospace and biomedical applications.

Text Books:

1. **Pradeep.T** "*A textbook of Nanoscience and Nanotechnology*", 1st edition, Tata McGraw – Hill education private ltd, 2012.
2. **Jeremy J. Ramsden**"*Applied Nanotechnology*, *Micro and Nano technology Series*", 1st Edition Elsevier, 2009.

Reference Books:

1. **Jeremy J. Ramsden"***Applied NanotechnologyThe Conversion of Research Results to Products***",**2ndEdition Elsevier, 2014.
2. **B.S. Murthy, P Shankar, Baldev Raj, B BRath, and James Murday, "***Textbook of Nanoscience and Nanotechnology"*, 1stedition, Universities Press, 2012.

Web Resources:

1. https://www.elsevier.com/books/applied-nanotechnology/ramsden/978-0-8155-2023-8

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC651OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	0	3	0	0	3	0	2	2	2	2	0	0	0	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Automotive Electronics	***Course Code: 20EC652OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-II***
CIE Marks: 50	***SEE Marks: 100***

Course Objective: Course Objective: Understand the basics of automobile dynamics and design electronics to complement those features. Design and implement the electronics that attribute reliability, safety, and smartness to the automobiles, providing add-on comforts.

Course Outcomes: After completing this course, students should be able to:

CO 1:	Explain the working of different sensors and actuators in fuel injection, ignition systems and Active / Passive safety systems.
CO 2:	Analyze, a comprehension of the roles and implementations of various bus systems used in automotive networking.
CO 3:	Exemplify the knowledge of basic principle of actuators and explain the mechanism of hybrid drives.
CO 4:	Demonstrate in a group and complete the assigned task by demonstrating skills related to documentation and oral communication.

Unit No.	Course Content	No. of Hours
1	**Electrical and electronic systems in the vehicle:** Overview, Motronic-engine management system, electronic diesel control, Lighting technology, electronic stability program, Adaptive cruise control, Occupant-protection systems.	8
2	**Networking and bus systems:** Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, coupling of networks, Examples of networked vehicles. **Architecture of electronic systems & Control Units:** Overview, Vehicle system architecture. Control units: Operating conditions, Design, Data processing, Digital modules in the control unit and control unit software.	8
3	**Automotive sensors:** Basics and overview, automotive applications, Sensor market, Features of vehicle sensors, Sensor classification, Selection of Sensor and Actuators**.**	8
4	**Sensor measuring principles:** Sensors for the measurement of position, speed, rpm, acceleration, pressure, force, and torque, Flow meters, temperature sensors, **Sensor types:** Engine speed sensors, Hall phase sensors, Sensors for transmission control & wheel speed, Yaw-rate sensors, Pressure sensors, Temperature sensors, Accelerator-pedal sensors, Steering angle sensors, Position sensors, Axle sensors, Piezoelectric knock sensors, Acceleration sensors, Force & torque sensors, Rain/light sensors.	8
5	**Actuators:** Electromechanical & fluid mechanical actuators, Electrical machines **Hybrid drives:** Drive concepts, operating strategies for electric hybrid vehicles, Recuperative brake system, Electrical energy accumulators.	7

Text Books:

1. **Robert Bosch GmbH,** *"Bosch Automotive Electrics and Automotive Electronics"*, 5th Edition, Springer Vieweg, 2014.
2. **William B. Ribbens,***"Understanding Automotive Electronics: An Engineering Perspective"*, 8thEdition, Elsevier, 2017

Reference Books:

1. **K. Babu,** *"Automotive Electrical and Electronics"*, Khanna Publishers, 1st Edition, 2018.
2. **John F. Kershaw, Ed.D. and James D. Halderman,** *"Automotive Electrical and Electronic Systems"*,5th Edition, Pearson Prentice Hall, 2007.
3. **Barry Hollembeak,** *"Automotive Electricity and Electronics"*, Cengage Learning, 6th Edition, 2014.

Web Resources:

1. https://www.youtube.com/playlist?list=PLCBA3EF828DFE7B0E
2. https://www.youtube.com/watch?v=STDlCdZnIsw&list=PLE06CAA834360BB39

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC652OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO4	0	0	0	0	3	0	0	2	3	0	0	0	2	0	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Smart Agricultural Technology	***Course Code: 20EC653OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objective: Able to understand smart farming for improving agricultural management by being able to implement transducers, sensors and actuators and advance motors for real time implementation of smart farming.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the Soil science, Plant anatomy and its health monitoring.
CO2:	Analyze the sensors and actuators for farming tools.
CO3:	Design and develop the sensor and actuators used for data acquisition and telemetry.
CO4:	Demonstrate the advanced technologies for smart farming and document the same.

Unit No.	Course Content	No. of Hours
1	**Soil Science:** Nature and origin of soil; soil minerals, classification and composition, soil reaction, soil properties including structure, pH, surface tension and soil nutrient	8
2	**Sensors:** Classification and characteristics, Smart sensors, Colorimetry based detection, MEMS Electrochemical Sensors, Dielectric Soil Moisture Sensors, ISFET, Weather sensors, Proximity Sensors, Signal conditioning and converters.	8
3	**Actuators:** Actuators for tool automation: A.C.-D.C. Motors, Stepper motor, Solenoid actuators, Piezoelectric motors, Electric drives, Hydraulic and Pneumatic actuator	8
4	**Telemetry:** Wireless communication modules and topology, Zig-bee, Bluetooth, LORA, Zero power devices, Energy Harvesting Technology.	8
5	**Technologies for farming:** Water quality monitoring, micro-irrigation system, solar pump and lighting system, Fencing, Android based automation, Agricultural Robots, Standards for agriculture.	7

Text Books:

1. **Brady, Nyle C**, "*The nature and properties of Soils*" Eurasia Publishing House Pvt Ltd, 1998.
2. **Ernest O. Doebelin**, "*Measurement Systems; Application and Design*", McGraw Hill, 1984

Reference Books:

1. **Aqeel-ur- Rehman,** "*Smart Agriculture an Approach Towards Better Agriculture Management*", OMICS International, 2015.
2. **Ville Kaajakari**, "*Practical MEMS: Design of microsystems, accelerometers, gyroscopes, RF MEMS, optical MEMS, and microfluidic systems*", Small Gear Publishing, 2009.

3. **Patranabis. D**, "*Principles of Industrial Instrumentation and control*", Tata McGraw Hill, 1995.
4. **Bolton W**, "*Mechatronics: A Multidisciplinary Approach*", Pearson Education Asia, 2004.
5. **Buresch, Mathew**, "*Photo-voltaic energy systems: Design and Installation*", McGraw-Hill Book Company, 1983

Web Resources:

1. **https://youtu.be/60YD5jsSlmo**
2. **https://youtu.be/LS3XGUZzLuI**
3. **https://youtu.be/nsnpEmr1q_k**
4. **https://youtu.be/WhAfZhFxHTs**
5. **https://www.youtube.com/watch?v=0WR4BeFcLks**

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC653OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Low Power VLSI	***Course Code: 20EC654OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-II***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics, CMOS VLSI.

Course Objective: Learn how to increase the battery life of portable devices, leakage and dynamic power reduction is emerging as a primary goal of the VLSI circuit design

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the Need for low power VLSI chips.
CO2:	Analyze the Low-Voltage CMOS Circuits at Architecture & Systems level.
CO3:	Demonstrate the simulation of Low power Architecture & Systems using EDA tool.

Unit No.	Course Content	No. of Hours
1	**Introduction:** Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits, Emerging Low power approaches. Device & Technology Impact on Low Power: short circuit and leakage in CMOS, Dynamic dissipation in CMOS.	8
2	**Low-Voltage CMOS Circuits:** Design style, Leakage current in Deep sub-micron transistors, device design issues, minimizing short channel effect, Low voltage design techniques using reverse Vgs, steep sub threshold swing and multiple threshold voltages, Testing with elevated intrinsic leakage, multiple supply voltages.	8
3	**Low Power Circuits:** Transistor and gate sizing, network restructuring and Reorganization, Special Flip Flops & Latches design	7
4	Low power digital cells library. Logic level- Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.	8
5	**Low power Architecture & Systems:** Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. Adiabatic Computation, Pass Transistor Logic Synthesis	8

Text Books:

1. **Gary K. Yeap**, "*Practical Low Power Digital VLSI Design*", KAP, 2002.
2. **Kaushik Roy, and Sharat Prasad**, "*Low-Power CMOS VLSI Circuit Design*", Wiley, 2000.

Reference Books:

1. **Anantha P. Chandrakasan, and Robert W. Brodersen**, "*Low Power Digital CMOS Design*", Kluwer Academic Publications, 2005.
2. **Rabaey, and Pedram**, "*Low Power Design Methodologies*", Kluwer Academic, 1997.

3. **Philip Allen, and Douglas Holberg**, "*CMOS Analog Circuit Design*", Oxford University Press, 2002.

Web Resources:

1. https://www.youtube.com/watch?v=ruClwamT-R0&list=PLTEh-62_zAfHmJE-pcjgREKiKyPSgjkxj
2. https://www.youtube.com/watch?v=K2kL7pMnL_0&list=PLVDb88QIgXkeeUo6I2oudLvc76GbLGrTi

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC654OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Artificial Intelligence and Deep Learning	*Course Code: 20EC655OE*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective Course-II*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts of Linear Algebra.

Course Objectiv:- To make the students understand about problem solving, inference, perception, knowledge representation, and learning in AI models. Also Deep learning network models used in training, testing and validating the data, different architectures of the deep learning models.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the basic principles of AI toward problem solving, inference, perception, Knowledge representation and learning.
CO2:	Analyze and evaluate the various search strategies and issues in design problems.
CO3:	Interpret the multi-layer perceptron with various structuring and tuning ofhyper parameters.
CO4:	Evaluate the working of various CNN architectures.

Unit No.	Course Content	No. of Hours
1	**Introduction to AI:**Intelligent Agents, Agents and environment, Rationality, the nature of environment, the structure of agents, Goal based agents, Utility based agents, Learning agents.	8
2	**Problem Solving and Search Techniques:**Problem space & search, defining the problem as state space search, Searching for Solutions, Uninformed Search Strategies, Breadth First search, Depth First Search, Iterative deepening depth first search, Informed Search Strategies, Heuristic functions.	8
3	**Deep learning and Neural Networks:** Perceptron, Multi-layer perceptron, Activation functions, feed forward process, error function, optimization algorithms and back propagation, classification using MLP.	8
4	**Structuring DL projects and hyper parameter tuning:**Defining performance metrics, designing baseline model and data preparation, evaluation of model, tuning hyper parameters, optimization, regularization and batch normalization.	8
5	**Convolutional neural network:**Architecture and Components of CNN, Image classification using CNN, Over fitting and dropout layer, LeNet-5, AlexNet.	7

SLE: Advanced CNN architectures like VGGNet, Inception, GoogleNet, ResNet

Text Books:

1. **Stuart Russel, Peter Norvig,**"Artificial Intelligence:A ModernApproach", 3rd Edition, Pearson Education, 2010(Twelfth Impression2018).
2. **Josh Patterson and Adam Gibson,** "Deep Learning, A practitioner's approach" O'Reily Media Inc., 1st Edition, 2017.
3. **Mohammed Elgandy,**"Deep Learning for Vision Systems", Manning Publication, 2020.

Reference Books:

1. **Elaine Rich, Kevin Knight, Shivashankar B Nair,** "Artificial Intelligence" Tata MCGraw Hill 3rd edition. 2013(24th Reprint 2018).

2. **Luca Pietro, Giovanni Antiga, Thomas Viehmann, Eli Stevens,**"Deep Learning with PyTorch", Manning Publications, ISBN: 9781617295263, July 2020.
3. **Ian Goodfellow, Yoshua Bengio, Aaron Courville**, "Deep Learning",The MIT Press, November 2016.

Web Resources:

1. **https://nptel.ac.in/courses/106105215**
2. **https://onlinecourses.nptel.ac.in/noc22_cs56/preview**

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC655OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3	3	
CO2		3												3	
CO3			3												3
CO4	3	3	3	3	3									3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Bioelectronics and Biosensors	*Course Code: 20EC661OE*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective Course-III*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts of signals and Electronics.

Course Objectives: To provide quality education in the interdisciplinary areas of bioelectronics, biosensors, nanotechnology, biotechnology, and advanced electronics.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the working principle of Bioelectronics and Biosensors.
CO2:	Apply the basic knowledge of sensors and actuators in biomedical instrumentation system.
CO3:	Analyze the applications of transducers, smart sensors and actuators in diagnosis.
CO4:	Demonstrate suitable sensors and transducers for real time applications.

Unit No.	Course Content	No. of Hours
1	**Bioelectronics:** Introduction, Potential advantages & Developments towards a bio molecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.	8
2	**Biosensors:** Introduction, principles, classification, various components of biosensors, Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte, Types of membranes used in biosensor constructions.	7
3	**Applications of Biosensors:** Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors inindustry, healthcare, food and environment.	8
4	**Bio-MEMS**: Introduction to bio-MEMS. Materials for bio-MEMS. BioMEMS fabrication: bulk/surface micromachining, LIGA. Soft fabrication and polymers (soft-lithography, micromolding, micro- stereolithography, thick-film deposition, SAMs. Microfluidic principles. Microfluidic devices: microchannels, microvalves, micropumps, micro- needles, microreserviors, micro-reactors. MEMS biosensors. Microactuators and micro drug delivery system. Micro total analysis system (μTAS), lab-on-a-chip. Microarrays: polymerase chain reactor (PCR), DNA chip, functional genomics, bioinformatics. BioMEMS for tissue engineering. Packaging, power, data and RF safety of bioMEMS	8
5	**Nano MEMS:** Introduction to Nano-MEMS. Materials for Nano -MEMS. Nano MEMS fabrication, applications of Nano MEMS, Packaging, power, data and RF safety of NanoMEMS	7

SLE: Future Trends in Neurosensors, Biosensors, Nano-technology, Soft Computing techniques in instrumentation.

Text Books:

1. **Brian R Eggins** - *Biosensors an Introduction* , First edition, John Wiley & Sons Publishers, 1996.
2. **Loic J Blum, Pierre R Coulet** - *Biosensors Principles and Applications*, First edition, Marcel Dekker,Inc, 1991
3. **Donald G. Buerk** - *Biosensors Theory and Applications*, First Edition Technomic Publishing. Co, Inc, 1993.
4. **Marc J. Madou,** *From MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications*, CRC Press, 1st edition, Jun.16, 2010, ISBN: 142005516X.

Reference Books:

1. **Elizabeth A Hall** - *Biosensors*, First Edition, Open University, Milton Keynes, 1990.
2. **Graham Ramsay** - *Commercial Biosensors*, First edition, John Wiley & Sons, Inc. 1998.
3. **Tran Minh Canh** - *Sensor Physics & Technology - Biosensors* , First Edition, Champan& Hall, 1993.
4. **Steven S. Saliterman**, *Fundamentals of BioMEMS and Medical Microdevices*, SPIE Publications, Jan. 19, 2006, ISBN: 0819459771.

Web Resources:

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.coursera.org/lecture/interface-with-arduino/lecture-2-1-actuators-uNCa4

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC661OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	2	0	0	3	3	0	0	0	3	2	0	2	2	0	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Optimization Techniques for Engineers	***Course Code:* 20EC662OE**
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-III***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of algebra and matrix operations.

Course objectives: The student will try to learn Operation research models using optimization techniques based on the fundamentals of engineering mathematics, the problem formulation by using linear, integer/dynamic programming, game theory, queuing models and network optimization/CPM/PERT techniques, Formulation of mathematical models for quantitative/simulation analysis of real world problems in industry.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe the concept and classification of optimization problem.
CO2:	Apply the knowledge of various methods and models for optimizing the given problem.
CO3:	Analyze and solve different models and techniques.
CO4:	Demonstrate the skill sets to simulate/ use analysis tools to solve real world problems.

Unit No.	Course Content	No. of Hours
1	**Development and Classification of optimization problems:** Definition, characteristics and phases, types of operation research models, applications, linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, big-M method.	8
2	**Network optimization models:** Transportation and assignment models, Finding initial basic feasible solution by north-west corner rule, least cost method and Vogel's approximation method, testing for optimality of balanced transportation problems. Shortest Route, Minimal Spanning Tree, Maximum Flow Models.	8
3	**CPM and PERT:** Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT) Networks. Drawing of networks, Removal of redundancy, Network computations, Free slack, Total slack, Crashing, Resource allocation.	8
4	**Integer and Dynamic Programming:** Branch and bound algorithm, Dynamic Programming, introduction, Terminology, Bellman's Principle of optimality, Applications of dynamic programming, shortest path problem, linear programming problem.	8
5	**Game theory and queuing models:** Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m X 2 & 2 X n games and Graphical method. Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Poisson arrivals and exponential service times with infinite population.	7

SLE: Case studies and applying optimization techniques for the engineering and business related problems and obtain the solution.

Text Books:

1. **Hiller and Lieberman**, *"Introduction to Operations Research"*,10th Edition, TMH publications, Reprint 2017.
2. **R. Pannerselvam,** *"Operations Research"*, 2nd Edition, PHI publications, 2006.

Reference Books:

1. **Hamdy Taha,***"Operations Research"*, 8th Edition, TMH publications, 2001.
2. **S D Sharma, "***"Operations Research"*,1st Edition, Kedarnath Ramnath and Co, 2000.

Web Resources:

1. https://nptel.ac.in/courses/112106134/
2. https://link.springer.com/book/10.1007/978-0-387-78977-4
3. https://nptel.ac.in/courses/112101298

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC662OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	3	2	0	0	0	0	0	0	0	0	0	2	0	2
CO4	0	0	0	0	3	3	2	2	3	2	2	2	2	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Professional Communication and Technical Report Writing	***Course Code:20EC663OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-III***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with the knowledge of English grammar and spellings.

Course objectives: The student will try to learn Vocabulary, language and writing skills relevant to engineering as a profession, Analyze, interpret and effectively summarize textual content, Create technical reports using LaTeX and present effective technical presentations.

Course Outcomes: After completing this course, students should be able to:

CO1:	Describe/develop vocabulary, language and writing skills relevant to engineering as a profession.
CO2:	Analyze, interpret and effectively summarize textual content.
CO3:	Create technical reports using LaTeX and effective technical presentations.
CO4:	Demonstrate the skill sets on a given technical/non-technical topic in a group and arrive at generalizations/consensus.

Unit No.	Course Content	No. of Hours
1	**Introduction:** communication-meaning, importance, dimensions and channels, barriers of communication, effective communication, essentials of good communication, types: verbal (oral and written) and nonverbal. Technical Written Communication: Nature, origin and development of technical written communication, features. Difference between technical writing and general writing.	8
2	**Technology-based communication:** Effective email messages, slide presentations, editing skills usingsoftware. Modern day research and study skills: search engines, repositories, forums such as GitHub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism	8
3	**Oral Presentation:** Voice modulation, tone, describing a process, Presentation Skills: Oralpresentation and public speaking skills, business presentations, improving presentation skills. Debate and Group Discussions (GD): introduction, differences between GD and debate; participating, understanding, and brainstorming the GD topic, questioning and clarifying, GD strategies, activities to improve GD skills.	8
4	**Technical Writing:** differences between technical and formal writing style. letter Writing(formal, informal and semi-formal), job applications, minute preparation, curriculum vitae (CV) preparation (differences between Bio-Data, CV and Resume), and reports. Basics of report/technical paper writing, guidelines: Referencing Style (IEEE styleguide), structure of a report; types of reports, references, bibliography. Differences between technical presentations and seminars.	8
5	**Introduction to LaTeX:** Standard practice of learningLaTeXand writing	7

	technical report using LaTeX commands, related exercises. Case studies on report writing, presentation and seminars.	

SLE: Editing softwares, review article, journal and conference paper writing/publishing.

Text Books:

1. **Goodheart-Willcox,***"Professional Communication"*, 1st edition, G-W publisher, 2017.
2. **Raman. Mand Sharma, S.,***"Technical Communication Principles and Practice,* 1st edition, Oxford University Press, New Delhi, 2011.

Reference Books:

1. **Butterfield, Jeff.,** *"Soft Skills for everyone"*,2nd edition,Cengage Learning New Delhi, 2013.
2. **Sherman, Theodore A. (et.al.),** *"Modern Technical Writing"*, 1st edition,Prentice Hall, New Jersey, 2017.
3. **Anna university author,** *"English for Engineers and Technologists"* (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
4. **Meenakshi Raman and Sangeetha Sharma,***"Technical Communication: Principles and Practice"*, 2nd Edition, Oxford University Press, 2011.

Web Resources:

1. https://www.pdfdrive.com/professional-communication-technical-writing-e43179325.html
2. https://nptel.ac.in/courses/102104061
3. https://nptel.ac.in/courses/109104031

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC663OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0
CO2	0	0	0	0	2	0	0	0	0	2	0	3	0	2	0
CO3	0	0	0	0	0	2	0	0	2	3	0	0	0	2	0
CO4	0	0	0	0	0	0	0	2	3	2	0	2	0	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

***Course Title:* Verilog HDL**	***Course Code:20EC664OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-III***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Digital System design.

Course Objectives: To design combinational, sequential circuits using Verilog HDL. To verify and design the digital circuit by means of Computer Aided Engineering tools which involves in programming with the help of Verilog HDL.

Course Outcomes: After completing this course, students should be able to:

CO1:	Write Verilog programs in gate, dataflow (RTL), behavioral and switch modeling levels of abstraction.
CO2:	Perform timing and delay Simulation and Interpret the various constructs in logic synthesis.
CO3:	Design and verify the functionality of digital circuit/system using test benches.
CO4:	Demonstrate by Identify the suitable Abstraction level for a given digital design and Write the programs more effectively using Verilog tasks, functions and directives.

Unit No.	Course Content	No. of Hours
1	**Overview of Digital Design with Verilog HDL:** Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL? Trends in HDLs. **Hierarchical Modeling Concepts:** Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block.	8
2	**Basic Concepts:** Lexical conventions, datatypes, system tasks, compiler directives. **Modules and Ports:** Module definition, port declaration, connecting ports, hierarchical name referencing.	8
3	**Gate-Level Modeling:** Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. **Dataflow Modeling:** Continuous assignments, delay specification, expressions, operators, operands, operator types.	8
4	**Behavioral Modeling:** Structured procedures, initial and always, blocking and non blocking statements, delay control, generate statement, event control, conditional statements, Multiway branching, loops, sequential and parallel blocks. **Tasks and Functions:** Differences between tasks and functions, declaration, invocation, automatic tasks and functions.	8
5	**Useful ModelingTeclmiques:** Procedural continuous assignments, overriding parameters, conditional compilation and execution, useful system tasks. **Logic Synthesis with Verilog:** Logic Synthesis, Impact of logic synthesis, Verilog HDL Synthesis, Synthesis design flow,Verification of Gate-Level Netlist.	7

Text Books:

1. **Samir Palnitkar, "Verilog HDL:** A Guide to Digital Design and Synthesis", 2nd Edition Pearson Education, 2012

Reference Books:

1. **Donald E. Thomas, Philip R Moorby,** '*The Verilog Hardware Description Language*", Fifth edition Springer Science+Business 2015.
2. **Michael D. Ciletti**, "*Advanced Digital Design with the Verilog HDL*" Second edition, Pearson (Prentice Hall), 2015.
3. **Padmanabhan, Tripura Sundari,** "*Design through Verilog HDL*", Wiley, 2016.

Web Resources:

1. https://www.pdfdrive.com/professional-communication-technical-writing-e43179325.html
2. https://nptel.ac.in/courses/102104061
3. https://nptel.ac.in/courses/109104031

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC664OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	3	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
CO4	0	0	0	3	3	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Power Electronics	***Course Code: 20EC665OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-III***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts electronics.

Course Objectives: To familiarize the switching devices, power converters and its applications in various systems for power control to prepare the students to analyze and design different power converter circuits,

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the various power devices and circuits.
CO2:	Analyze different power electronics circuits.
CO3:	Design power electronics circuits to meet the given specifications.
CO4:	Demonstrate the skill sets using modern tool for analysis and simulation of power electronics circuits.

Unit No.	Course Content	No. of Hours
1	Power Semiconductor Devices: Introduction to Power Electronics- Power Diodes- Types, rating and switching characteristics. Current controlled devices- BJTs and Thyristors – Construction, operation, switching characteristics, rating and types. Voltage controlled devices: Power MOSFETs and IGBTs – construction, operation, switching characteristics, rating and types. Principles of series and parallel operation of power switching devices. Different types of Power Electronic circuits.	8
2	Firing and Protection Circuits: Firing circuits for power electronic devices, Gate driver circuits for SCR, MOSFET and IGBT and base driving for power BJT, Over voltage, over current and gate protections, Necessity of isolation, pulse transformer, opto-coupler , Design of snubbers.	8
3	Controlled Rectifiers: Introduction, Performance of Single phase fully controlled and semi controlled converters with R and RL Loads for continuous and discontinuous current modes. AC Voltage Controllers: - Introduction, On-Off and Phase control, Single –phase Bidirectional controllers with resistive and inductive loads.	8
4	DC – DC Converters or Choppers: Introduction, principle of operation, analysis of Buck, Boost, and Buck-boost converters, operation with R and RL loads, and their control strategies, performance parameters and classification.	8
5	Inverters: Introduction, principle of operation, performance parameters, and control strategies of Single phase Full and Half Bridge inverters with R and RL Loads, Introduction to Three phase, Current source inverters, Power Supplies: UPS, SMPS.	7

Text books:

1. **Muhammad H. Rashid**: *"Power Electronics – Circuits, Devices and Applications"*, 3rd edition, Pearson Education/ PHI, 2011.
2. **R.S. Ananda Murthy, V. Nattarasu**: *"Power Electronics"*, 2nd Edition, Sanguine Technical Publishers, India, 2005.

Reference books:

1. **Daniel W. Hart**: "*Power Electronics*", 1st Edition, McGraw Hill, 2011.
2. **L. UMANAND**: "*Power Electronics Essentials and applications*", 3rd Edition, John Wiley and sons, Inc, 2009.
3. **V.R Moorthi**: "*Power Electronic Devices, Circuits & Industrial Applications*", 1st Edition, Oxford University Press, 2005.

Web Resources:

1. https://www.youtube.com/playlist?list=PLgwJf8NK-2e5Hnu82T1CYLZ8kbZs4Jx8x
2. https://www.youtube.com/playlist?list=PL_mruqjnuVd9_mwhgK3nAy-cHyslXCnRk

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC665OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2					
CO2		3							2	2			3		
CO3			3						2	2			3		
CO4					3				3	2				3	

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Open Electives
VII - Semester

Course Title: Product Design and development	***Course Code: 20EC741OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective course-IV***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: All Engineering subjects that helps in product development

Course Objective:

To conceptualize a product that is needed by the society
To convert the concept into product
To Design and test the product
To analyze the product usage and its market acceptance
Product sustenance and future improvement

Course Outcomes: After completing this course, students should be able to:

CO1:	Conceptualize the product according to market requirement
CO2:	Conduct market survey and arrive at decision about the product
CO3:	Develop Prototype
CO4:	Product analysis and documentation

Unit No.	Course Content	No. of Hours
1	Introduction to products, services and methods. Product types, need for new product, factors influencing new product development, Engineering economics around the product, Engineer and society, Product and Environment, Ethical issues around new product.	8
2	Product concept, idea, design and development and Tech analysis	8
3	Product Market Acceptance, sustenance and product improvement, value addition in society by using the product.	8
4	Product manufacturing product pricing, profit and taxation and funding.	8
5	Advancements in product development methods open development GPL and IPR	7

Text Books:

1. **Planchard, D. C. and Planchard, M. P,** "*Engineering design with Solid Works*" 2012: A step-by-step project based approach utilizing 3D solid modeling, Schroff Development Corporation, Mission, Kansas. ISBN 978-1-58503-697-4.
2. **Dieter George E**., "*Engineering Design – A Materials and Processing Approach*", McGraw Hill, International Edition Mechanical Engg ., Series ,1991.

References:

1. **Krishnaswamy, K.N., Sivakumar, Appa Iyer & Mathirajan M**. – "*Management Research Methodology: Integration of Principles, Methods & Techniques*" (New Delhi, Pearson Education), 2006.
2. **Montgomery, Douglas C.** – "*Design & Analysis of Experiments*", 5/e. (New York, John Wiley & Sons), 2004

E resource:

1. **IPR references from various websites**

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

20EC741OE	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	3	0	0	0	3	0	0	0	0	0	0	3	0	0
CO2	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0
CO3	0	0	3	3	0	0	0	0	0	0	0	0	0	3	0
CO4	0	3	0	0	0	0	0	0	0	3	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Hybrid Vehicles	*Course Code: 20EC742OE*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective course-IV*
CIE Marks: 50	*SEE Marks: 100*

Course Objectives: The students will be able to explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals, explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles, analyze various electric drives suitable for hybrid electric vehicles.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the importance and the basics of hybrid vehicles.
CO2:	Explain the architecture of hybrid electric vehicle and energy storage technologies
CO3:	Analyze various electric drives of HEV
CO4:	Design vehicle control models used in automobile
CO5:	Design and demonstrate the models of automobile using simulation tool.

Unit No.	Course Content	No. of Hours
1	**Introduction to Hybrid Electric Vehicles:** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles:** Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	8
2	**Hybrid vehicle architectures:** Series hybrid vehicle architectures- range extender and full hybrid systems, Parallel hybrid architectures, Plug-in hybrid architectures, commercially available electric and hybrid vehicles. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	8
3	**Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Battery Management System (BMS)/Energy Management System (EMS)	8
4	Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	8
5	Power Electronics Converters: Power Electronics Converters, DC/DC Converters, Cell Balancing Converters.	7
SLE	Recent trends and current publications on Hybrid Vehicles.	

Text Books:

1. **William B. Ribbens,** "*Understanding Automotive Electronics*", 5th Edition, Butterworth, Heinemann Woburn, 1998.
2. **Sethi H.M**, *"Automobile Technology"*, Tata McGraw-Hill-2003.

References:

1. **Crouse and Anglin** "*Automotive Mechanism"*, 9th Edition. Tata McGraw-Hill, 2003.
2. **Newton, Steeds and Garet**, *"Motor vehicles"*, Butterworth Publishers, 1989.
3. **Srinivasan.S,** "*Automotive Mechanics"* 2nd edition, 2003, Tata McGraw-Hill.
4. **Joseph Heitner,** "*Automotive Mechanics"*, 2nd edition, East-West Press, 1999.

E resource:

1. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLCBKiW2ShR0B5Rs-ytbbp-uyiPAzqdZts
2. https://www.youtube.com/watch?v=BMrA-5EDakg&list=PLQnccOCAloDQXQ62BTGvsRQFBBisedbJT
3. https://www.youtube.com/watch?v=ErV5lGVso1w&list=PL2ir4svMoaYj48N0VWoic25P9LaU2wlbA
4. https://www.youtube.com/watch?v=hcNqUZ1TiRM&list=PL2CubuFTe28NyTyClUCMizxksWmmeY36x

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

20EC742OE	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO4	0	3	3	3	0	2	0	0	0	0	0	0	0	2	0
CO5	0	0	3	3	3	2	3	0	2	0	2	2	0	3	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Deep Learning for NLP	***Course Code: 20EC743OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-IV***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Students should be familiar with basic mathematics.

Course Objective

Students will learn the concepts on natural language processing and deep leaning. The course will enable the students to analyze CNN and Deep learning algorithms for different applications.

Course Outcomes: After completing this course, students should be able to:

CO1:	Familiarize the concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS
CO2:	Explain the theoretical foundations, algorithms, and methodologies of Neural Network
CO3:	Analyze the CNN and Deep Learning architecture and Algorithm.
CO4:	Implement a Deep Learning algorithm for real-world applications.

Unit No.	Course Content	No. of Hours
1	**Fundamentals:**What is Natural Language Processing, Origin of NLP, Language and Knowledge, The challenges of NLP, Language and Grammer, Processing Indian Languages, NLP Applications,Language Modelling: Various Grammar-based Language Models, Statistical Language Model.	8
2	**Word Level Analysis:** Regular Expressions, Finite State automata, Morphological parsing, Spelling Error Detection and correction, words and word classes, part of speech tagging, Syntactic Anlaysis: Context free Grammar, Constituency, Parsing, Probabilistic parsing, Architectute of NLG Systems, Generation Tasks and Representations, Application of NLG.	8
3	**Machine Transaltion:** Problems in Machine Translation, Characteristics of Indian Languages, Machine Translation Approaches, Direct Machine Translation, Rule-based machine translation, corpus based machine translation, Semantic or Knowledge based MT System, Transaltion involving Indian Languages	8
4	**Basics of Deep Learning:** Introduction,Perceptron Algorithm Explained**,** Multilayer Perceptron, Deep Learning, Model Training, Unsupervised Deep Learning, Framework Considerations	8
5	**Convolutional Neural Networks:** Basic Building Blocks of CNN, Forward and Backpropagation in CNN, Text Inputs and CNNs, Classic CNN Architectures, Modern CNN Architectures, Applications of CNN in NLP, Fast Algorithms for Convolutions	7

SLE: Computer Experiments - Linear Prediction, Pattern Classification, Pattern Classification using supervising, Semisupervised Learning.

Text Books:

1. **Tanveer Siddiqui, U S Tiwary,***Natural Language Processing & Information Retrieval*, Oxford Higher Education, Sixth impression, 2018.
2. **Uday Kamath, John Liu, James Whitaker,***Deep Learning for NLP and Speech Recognition*, Springer, 2019

Reference Books:

1. **NitinIndurkhya, Fred J. Damerau,***Handbook of Natural Language Processing*, Second Edition, CRC Press, 2010.
2. **James Allen**,*Natural Language Understanding*, Pearson Publication 8th Edition, 2012.
3. **Chris Manning**, **HinrichSchütze**, *Foundations of Statistical Natural Language Processing*, 2nd edition, MIT Press Cambridge, MA, 2003.
4. **Umberto Michelucci**, *Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks*,Apress, 2018.

Web Resources:

1. https://nptel.ac.in/courses/106106184
2. https://nptel.ac.in/courses/106105158
3. https://nptel.ac.in/courses/106106211

Mapping - Course Outcomes with Program outcomes & Program-Specific outcomes

	Program outcomes												Program-specific outcomes		
EC320	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3		2										2	3
CO3			3											2	3
CO4	3	3	2	2	3	2	2	2	3	3	2	3	3	2	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: ASIC	***Course Code: 20EC744OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-IV***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: To prepare the student to be an entry level industrial standard cell ASIC and to give the student an understanding of issues and tools related to ASIC design

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the concepts of ASIC design methodology and performance parameter of CMOS Logic circuits.
CO2:	Analyze the ASIC Library design with different hierarchical design entry.
CO3:	Design the ASIC circuit with floor planning and routing techniques for specific application.
CO4:	Demonstrate by simulation of CMOS circuits for ASIC using EDA tool.

Unit No.	Course Content	No. of Hours
1	**Introduction to ASICs:** Full custom, Semi-custom and ProgrammableASICs, ASIC Design flow, ASIC cell libraries. **CMOS Logic:** Data path Logic Cells: Data Path Elements, Adders: Carryskip, Carry bypass, Carry save, Carry select, Conditional sum, Multiplier(Booth encoding), Data path Operators, I/O cells, Cell Compilers.	8
2	**ASIC Library Design:** Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages, library cell design.	8
3	**Low-level design entry:** Schematic entry: Hierarchical design, The cell library, Names, Schematic Icons & Symbols, Nets, Schematic Entry for ASICs, Connections, vectored instances & buses, Edit in place, attributes, Netlist screener. **ASIC Construction:** Physical Design, CAD Tools System partitioning, Estimating ASIC size and Partitioning.	8
4	**Floor planning and placement:** Goals and objectives, Measurement of delay in Floor planning, Floor planning tools, Channel definition, I/O and Power planning and Clock planning. **Placement:** Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Time driven placement methods, Physical Design Flow.	8
5	**Routing:** Global Routing: Goals and objectives, Global Routing Methods, Global routing between blocks, Back-annotation. Detailed Routing	7

Text Books:

1. **Michael John Sebastian Smith,** "Application - Specific Integrated Circuits" AddisonWesley Professional; 2005.
2. **Rakesh Chadha, Bhasker J.,** "An ASIC Low Power Primer", Springer, ISBN: 978-1-4614-4270-7.

Reference Books:

1. **Neil H.E. Weste, David Harris, and Ayan Banerjee,** "CMOS VLSI Design: A Circuitsand Systems Perspective", 3rd edition, Addison Wesley/ Pearson education, 2011.
2. **Vikram Arkalgud Chandrasetty,** "VLSI Design: A Practical Guide for FPGA and ASIC Implementations", Springer, 2011, ISBN: 978-1-4614-1119-2.

Web Resources:

1. https://youtu.be/qee-ahSeKiU?list=PLfGJEQLQIDBN0VsXQ68_FEYyqcym8CTDN

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC7440E	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0										
CO2	0	3	0	0	0								2		
CO3	0	0	3	0	0									3	
CO4	0	0	0	3	3				3			2		3	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Embedded Systems	***Course Code: 20EC745OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-IV***
CIE Marks: 50	***SEE Marks: 100***

Course Objective: The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

Course Outcomes: After completing this course, students should be able to:

CO – 1	Explain the major components that constitute an embedded system.
CO – 2	Analyze the basic structure of embedded systems.
CO – 3	Apply contemporary techniques for Hardware-Software co-design of embedded systems for Real time applications using RTOS.
CO – 4	Design real time embedded systems using the concepts of RTOS, simulate using modern software tools through group projects and give effective oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	Introduction: Embedded Systems and general-purpose computer systems, history, classifications, applications and purpose of embedded systems. Core of Embedded Systems: Microprocessors and microcontrollers, RISC andCISC controllers, Big endian and Little-endian processors, Application specific ICs, Programmable logic devices, COTS, sensors and actuators, communication interface, embedded firmware, other system components, PCB and passive components.	8
2	Characteristics and quality attributes of embedded systems: Characteristics, Operational and non-operationalquality attributes, application specific embedded system- washing machine, domain specificautomotive.	8
3	Devices and Communication Buses for Device Network: I/O types and examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing features in Device Ports, Wireless Devices, Timers and counting Devices, Networked Embedded Systems, Serial Bus Communication Protocols, Parallel Bus Device Protocols, Network Protocols, Wireless and Mobile system protocols.	8
4	Hardware Software Co-Design, Program Modeling, Embedded Firmware Design and Development: Fundamental Issues in Hardware Software Co-Design, Computational models in Embedded Design, Hardware Software tradeoffs, Embedded Firmware Design approaches, Embedded Firmware Development languages, Programming in Embedded C.	8
5	RTOS based Embedded System Design: OS basics, Types of Operating Systems, Tasks, process and Threads, Multiprocessing and Multi-tasking, Task Scheduling, Threads, Processes and Scheduling, Task Communication, Task Synchronization, Device Drivers, how to choose an RTOS.	7

Text Books:

1. **Raj Kamal:** "*Embedded Systems - SoC, IoT, AI and Real-Time Systems*", 4th Edition, TMH, 2020.
2. **Shibu K V:** *"Introduction to Embedded Systems"*, 2ndEdition, TMH, 2017.

Reference:

1. **James K Peckol:** "*Embedded Systems- A Contemporary Design Tool*", 1st edition, John Wiley, 2019.
2. **Santanu Chattopadhyay,** "*Embedded System Design*", 2nd edition, PHI Learning, 2013

Web Resources:

1. https://nptel.ac.in/courses/108102045/
2. https://nptel.ac.in/courses/106105193/
3. https://nptel.ac.in/courses/106105159/
4. https://www.youtube.com/watch?v=JO4AEkOVF2M&list=PLrjkTql3jnm-lZMoUb1xMCp0HgxvJ7ocx
5. https://www.coursera.org/learn/introduction-embedded-systems

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Programspecificoutcomes		
20EC745OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3												3	
CO3			3												3
CO4								3	3	3			2	2	

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Analog and Mixed Mode VLSI	***Course Code: 20EC751OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-V***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objective: The course aims to teach advanced design techniques for single stage amplifier, differential pair Op-Amp circuit, oscillators and PLL

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the working principle of analog circuits.
CO2:	Analyze the transient, AC and DC response for analog CMOS circuits.
CO3:	Evaluate the performance parameters of analog and mixed signal CMOS circuits.
CO4:	Design, Demonstrate and validate the mixed mode circuits for linear applications using EDA tool.

Unit No.	Course Content	No. of Hours
1	**Basic MOS Device Physics:** General considerations, MOS I/V Characteristics, second order effects, MOS device models. Single stage Amplifier: CS stage with resistance load, divide connected load, current source load, triode load, CS stage with source degeneration, source follower, common-gate stage, cascade stage, choice of device models.	8
2	**Frequency response of CS stage:** source follower, Common gate stage, Cascade stage and Difference pair. Noise in CS stage, C- G stage, source follower, cascade stage, differential pair..	8
3	**Differential Amplifiers & Current Mirrors:** Basic difference pair, common mode response, Differential pair with MOS loads, Gilbert cell. Basic current mirrors, Cascade mirrors, active current mirrors.	8
4	**Operational Amplifiers:** One Stage OP-Amp. Two Stage OP-Amp, Gain boosting, Common Mode Feedback, Slew rate, Power Supply Rejection, Noise in Op Amps.	8
5	**Oscillators and Phase Locked Loops:** Ring Oscillators, LC Oscillators, VCO, Mathematical Model of VCO. Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications	7

Text Books:

1. **BehzadRazavi:** "*Design of Analog CMOS Integrated Circuits,"* McGraw – Hill international Edition, Electrical Engineering Series, 2001.
2. **Phillip E. Allen, Douglas R. Holberg:**"*CMOS Analog Circuit Design,"* 2nd Edition, Oxford University Press, 2002.

Reference Books:

1. **R. Jacob Baker.** "CMOS*: MIXED-SIGNAL CIRCUIT DESIGN,"*IEEE Press Series on microelectronics systems, A John Wiley & Sons, Inc., Publication 2008.
2. **Neil H. E. Weste**, "*CMOS VLSI Design: A Circuits and Systems Perspective*". Publishing House of Electronics Industry. 2011

Web Resources:

1. https://youtu.be/Q3WYZF5wzgU?list=PLbMVogVj5nJQB44z6h0XO2644Vbv7OM8_ - Lecture series on Electronics - CMOS Analog VLSI Design
2. https://youtu.be/DfSG8FzFGfo?list=PLUtfVcb-iqn9PmsLh_tkzhlNfIFdk_NsI – Lecture Series on Analog Circuits and Systems through SPICE Simulation – NPTEL

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC751OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	3	3	0	0	0	3	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Wireless Sensor Networks	*Course Code: 20EC752OE*
Credits : 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective Course-V*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Students should be familiar with basic concepts of computer Networks.

Course Objectives: Design a wireless sensor network for given sensor data using microcontroller, transceiver, middleware and operating system.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the fundamental knowledge about the architecture of wireless sensor networks.
CO2:	Demonstrate the working of flow control and Error control MAC protocols of WSN.
CO3:	Apply and analyze the principles of data transmission, routing protocols and its
CO4:	Analyze the challenges and design issues of transport layer, security, and the QOS.

Unit No.	Course Content	No. of Hours
1	**Overview of Wireless Sensor Networks:** Key definitions of sensor networks, Advantages of sensor Networks, Unique constraints and challenges, Applications, Enabling Technologies for Wireless Sensor Networks. **ARCHITECTURES**: Single-Node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design problem of WSN, Gateway Concepts. Networking technologies- Physical Layer and Transceiver Design Considerations.	8
2	**MAC Protocols for Wireless Sensor Networks**: Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention – Based Protocols, Contention – Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, IEEE 802.15.4 Mac Protocol. Link Layer Protocols - Error Control, Framing and Link Management.	8
3	**Routing Protocols**: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table – Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols, Proactive Routing.	8
4	**Transport Layer and Qos**: Challenges of transport layer protocol in wireless environments- TCPs challenges and design issues in ad hoc networks-Transport protocols for ad hoc networks-Transport control protocols for WSNs-Issues and challenges in providing QoS in ad hoc networks-Network layer QoS solutions QoS Model-QoS in wireless sensor networks-Congestion control in network processing.	8
5	**Security in WSNs:** Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management, Secure Routing in Ad Hoc	7

	Wireless Networks. **APPLICATIONS of WSNs**: Ultra wide band radio communication, Wireless fidelity systems, Home automation, smart metering Applications.	

SLE: Examples of Some Sensors Nodes, Sensor-MAC Case study, Geographical Routing, Performance analysis of Transport Control Protocols & Congestion, Network Management for WSN.

Text Books:

1. **Holger Karl ,Andreas Willig**, -"*Protocols and Architectures for Wireless Sensor Networks*", John Wiley, 2005.
2. **KazemSohraby, Daniel Minoli, &TaiebZnati**, "*Wireless Sensor Networks- Technology, Protocols, and Applications*", John Wiley, 2007.

Reference Books:

1. **WaltenegusDargie, Christian poellabauer**, "*Fundamentals of Wireless Sensor Networks*", Wiley, 2010.
2. **C. Siva Ram Murthy, B.S.Manoj**–"*Ad Hoc Wireless Networks: Architectures and Protocols*", PHI, 2004.

Web Resources:

1. https://nptel.ac.in/courses/106105160/
2. http://www.tfb.edu.mk/amarkoski/WSN/Kniga-w02
3. https://pdfs.semanticscholar.org/e87f/5253451603be6ef1b5d56700ed8048a33d61.pdf
4. http://profsite.um.ac.ir/~hyaghmae/ACN/WSNbook.pdf

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC752OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	3	3
CO4	3	3	3	3	3	0	0	0	0	0	0	0	0	3	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Mobile Computing	***Course Code: 20EC753OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-V***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Basics of Mobile Communication.

Course Objective: This course will examine the area of wireless networking and mobile computing, looking at the unique network protocol challenges and opportunities presented by wireless communications and host or router mobility. The course will give a brief overview of fundamental concepts in mobile wireless systems and mobile computing.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the evolution of wireless and mobile communication networks with respect to their technical features and applications
CO2:	Analyze the fundamental concepts of mobile computing and identify the challenges related to mobile operating systems.
CO3:	Evaluate the different inter-networking challenges and Wireless Application Protocol (WAP) for Internet access
CO4:	Simulate real time computing problems using modern software tools through group projects and give oral presentation with documentation.

Unit No.	Course Content	No. of Hours
1	Wireless and Mobile Network Architecture: Principle of Cellular Communication, Overview 1G, 2G, 2.5G and 3G and 4G technologies. GSM Architecture and Mobility management hand off management, Network signaling.	8
2	Mobile Computing fundamental challenges, Mobile Devices –PDA and mobile OS, Palm OS, Win CE, Symbian, Android and iOS.	8
3	Mobile IP and IP v 6 and its application in mobile computing, Cellular Digital Packet Data (CDPD), VOIP, GPRS Services, Wireless Local Loop (WLL) system.	8
4	Wireless Application Protocol (WAP): The Wireless Application Protocol application environment, wireless application protocol client software, hardware and websites, wireless application protocol gateways, implementing enterprise wireless application protocol.	8
5	Wireless Mark-up Language: An Introduction to Wireless Technologies, Markup Languages, An Introduction to XML, Fundamentals of WML., Writing and Formatting Text, Navigating between Cards and Decks, Displaying Images, Tables, Using Variables, Acquiring User Input.	7

Text Books:

1. Raj Kamal: “Mobile Computing”, Second Edition, Oxford University Press,2013
2. Ashoke K Talukder, Hasan Ahmed and Roopa R Yavagal: “Mobile Computing”, Second Edition, Tata McGraw Hill, 2010.

Reference Books:

1. Yi Bing Lin and Imrich Chlamtac: “Wireless and Mobile Networks Architecture”,Third Edition, John Wiley,2008
2. Uwe Hansmann, Lothar Merk, Mertin S Nickloue and Thomas Stober: “Principles of Mobile Computing” Second Edition, Springer International Edition, Springer Professional Computing, 2003.

Web Resources:

1. https://www.youtube.com/watch?v=5MoIg5lWLXA
2. https://www.youtube.com/watch?v=Rjluns-AEnc
3. https://www.youtube.com/watch?v=oxTUC5I22LU&list=PLE6yE0jB6BTMJXIXw4PS1kOqqZ9ty7eoG
4. https://www.youtube.com/watch?v=uIPtLr8R1-U&list=PLE6yE0jB6BTOY6Z1DKEkQ8yZ8fFPUiCD8

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC753OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
CO4	0	0	0	0	0	0	0	3	3	3	0	0	2	2	0

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Robotics and Computer Vision	***Course Code: 20EC754OE***
Credits : 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Open Elective Course-V***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Control Systems, Linear Algebra

Course Objective: To develop conceptual and analytical skills for students in Robotics and Computer Vision. To inculcate software and hardware skills to analyze, navigate and control robotics systems equipped with or without vision based sensors.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain mathematically, the position and orientation information of the object in an environment.
CO2:	Analyze the kinematics and dynamics concepts required to manipulate and control robot.
CO3:	Apply the techniques to estimate the location of robot and navigate.
CO4:	Demonstrate the working of robots for the given specification using modern hardware and software tools.

Unit No.	Course Content	No. of Hours
1	**Representing position & orientation:** Pose in 2-dimensions, Pose in 3-dimensions, orthonormal rotation matrices, homogeneous transformation matrices, Euler angles, roll-pitch-yaw angles, gimbal lock, quaternions **Time & motion Trajectories:** 1-dimensional, multi-dimensional, multi-segment, Interpolation of rotation, Smooth Cartesian motion, Time-varying coordinate frames, angular velocity, Inertial navigation solution	8
2	**Sensors and Actuators in Robotics:**Gyroscope, Accelerometer,Contact and Proximity Sensor, Position and Velocity sensors, Introduction to Cameras, Camera calibration,Geometry of Image formation, Euclidean/Similarity/Affine/ProjectiveTransformations Electric, Hydraulic and Pneumatic actuators; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators	8
3	**Kinematics**: Forward kinematics, Inverse kinematics, Trajectories Assigning Denavit-Hartenberg parameters, Applications Velocity relationships Manipulator Jacobians, Resolve-rate motion control Force relationships, under and over actuated manipulators	8
4	**Mobile Robot Vehicles:** Mobility, Bicycle and Car like models, moving to a point, line & pose, Modeling of Quadcopter (Flying robots) **Navigation**: Reactive navigation, Braitenberg vehicles, Bug* automata, Distance transform, D*Roadmap algorithm, Extended Kalman filter	8
5	**Dynamics**: Lagranges method of modelling of dynamics, Applying for Robotics links and joints, Independent Joint control, Rigid body equations of motion: gravity, inertia, Coriolis Forward dynamics	7

SLE	Position Based Visual Servo and Image Based Visual Servo, Applications in Health care

Text Books:

1. **Peter Corke,**"*Robotics, Vision and Control: Fundamental Algorithms In MATLAB"*, Second Edition, Springer, 2017
2. **S. K. Saha, "***Introduction to Robotics"*, 2nd Edition, McGraw Hill Education, 2017

Reference Books:

1. **Saeed B Niku, "***Introduction to Robotics: Analysis, Control, Applications"*, Student Edition, Wiley, 2011
2. **R. K. Mittal** and **I. J. Nagarath**: *"Robotics and Control"*, 6th Reprint, Tata Mcgraw-Hill Education, Delhi 2007.

Web Resources:

1. https://petercorke.com/
2. http://www.roboanalyzer.com/
3. https://nptel.ac.in/courses/107106090
4. https://www.youtube.com/channel/UCiK0J5wtnyX2jP-AiGbdhjg

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												**Program specific outcomes**		
20EC754OE	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3												3		
CO2		3												3	
CO3			3											3	3
CO4	3	3	3	3	3			3	3	3			3		3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Industrial Automation	***Course Code: 20EC755OE***
Credits: 3	***Total Contact Hours (L:T:P): 39:0:0***
Type of Course: Theory	***Category: Category: Open Elective Course-V***
CIE Marks: 50	***SEE Marks: 100***

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objectives: This course provides theoretical and practical aspects of implementing automation in industry. This course offers learning of pneumatics/ hydraulics systems, electrical controls and Programmable logic controllers.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the importance of automation techniques manufacturing and process industries.
CO2:	Analyze the impart role of PLC in industry automation.
CO3:	Develop various control techniques employed in process automation.
CO4:	Demonstrate the automation system for manufacturing and process industries.

Unit No.	Course Content	No. of Hours
1	**UNIT 1: Introduction** Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process.	8
2	**UNIT 2: Material handling and Identification Technologies** The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems , Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc. **Automated Assembly Systems:** Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multistation Assembly Machines, Analysis of a Single Station Assembly Machine.	8
3	**UNIT 3: Control Technologies in Automation** Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules ,SCADA System, HMI & RTU.	8
4	**UNIT 4: Automated Inspection and Testing** Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor and Actuators for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.	7
5	**UNIT 5: Programmable Logic Controllers (PLCs)** Introduction, Micro PLC, Programming a PLC, Logic Functions, Input &	8

	Output Modules, PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.	

Text Books:

1. **"Automation, Production Systems and Computer Integrated Manufacturing"**- M.P. Grover, Pearson Education.

Reference Books:

1. **"Computer Based Industrial Control"** – Krishna Kant, EEE-PHI.
2. **"Principles and Applications of PLC"** – Webb John, Mcmillan 1992
3. **"An Introduction to Automated Process Planning Systems"** – Tiess Chiu Chang & Richard A. Wysk
4. **"Anatomy of Automation"** – Amber G.H & P.S. Amber, PrenticeHall.

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC755OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0
CO4	0	0	0	3	3	0	0	0	0	0	0	0	0	0	3

0---No association, 1---Low association, 2--- Moderate association, 3---High association

Course Title: Telecommunication System Modeling and Simulation	*Course Code: 20EC756OE*
Credits: 3	*Total Contact Hours (L:T:P): 39:0:0*
Type of Course: Theory	*Category: Open Elective Course-V*
CIE Marks: 50	*SEE Marks: 100*

Pre-requisite: Student should be familiar with basic concepts of Electronics.

Course Objective: Develop and analyze simulation models using input analyzer and output analyzer. Able to explain Verification and Validation of simulation models.

Course Outcomes: After completing this course, students should be able to:

CO1:	Explain the random variables and random process for modeling of radio communication channels.
CO2:	Apply the basic knowledge of various simulation methodologies and performance evaluation of analog and digital signals in various applications.
CO3:	Analyze some advanced communication techniques as case studies through simulation
CO4:	Demonstrate the case studies through simulation for real time applications.

Unit No.	Course Content	No. of Hours
1	**Simulation of Random Variables Random Process:** Generation of random numbers and sequence, Guassian and uniform random numbers Correlated random sequences, Testing of random numbers generators, Stationary and uncorrelated noise,	8
2	**Modeling of Communication Systems:** Radio frequency and optical sources, Analog and Digital signals, Communication channel and models, Free space channels, Multipath channel and discrete channel noise and interference	8
3	**Estimation of Performance Measure For Simulation:** Quality of estimator, Estimation of SNR, Probability density function and bit error rate, Monte Carlo method, Importance sampling method, Extreme value theory.	8
4	**Simulation and Modeling Methodology:** Simulation environment, Modeling considerations, Performance evaluation techniques, error source simulation, Validation.	8
5	**Case Studies:** Simulations of QAM digital radio link in environment, Light wave communication link and satellite system.	7

Text Books:

1. **MC. Jeruchim, P.Balaban and Sam K Shanmugam**, "*Simulation of communication Systems: Modeling, Methodology and Techniques* ", Plenum press , New York, 2001.

Reference Books:

1. **Averill.M.Law and W.David Kelton**,"*Simulation Modeling and Analysis*", McGraw-Hill Inc., 2000.
2. **Geoffrey Gorden**, "*System Simulation*", Prentice Hall of India, 2nd Edition, 1992.
3. **W.Turin,** "*Performance Analysis of Digital Communication Systems*", Computer Science Press,NewYork, 1990.
4. **Jerry banks and John S. Carson**, "*Discrete Event System Simulation*", Prentice Hall of India, 1984.

Web Resources:

1. https://nptel.ac.in
2. https://www.coursera.org

Mapping - Course Outcomes with Program outcomes & Program Specific outcomes

	Program outcomes												Program specific outcomes		
20EC756OE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
CO3	0	3	3	0	0	0	0	0	0	0	0	0	0	2	0
CO4	2	0	0	3	3	0	0	0	3	0	0	2	0	2	2

0---No association, 1---Low association, 2--- Moderate association, 3---High association