Educate Elevate Enlighten

JSS Mahavidyapeetha

JSS Science And Technology University

(Established Under JSS Science and Technology University Act No. 43 of 2013)

(Formerly Known as SJCE)

JSS SCIENCE AND TECHNOLOGY UNIVERSITY MYSURU

JSS MAHAVIDYAPEETHA

JSS SCIENCE & TECHNOLOGY UNIVERSITY, MYSURU

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHEME OF I TO VIII SEMESTER: 2018-2019

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

(For Students admitted during 2018 – 19)

Vision

- **Advancing JSS S&T University as a leader in education, research and technology on the international arena.**
- **To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.**
- **Accomplishing JSS S&T University as an epicentre for innovation, centre of excellence for research with state of the art lab facilities.**
- **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.**

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 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.**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Semester Wise Credits

Sl. No.	SEMESTER	CREDITS
1.	I	19.5
2.	II	21.5
3.	III	25.0
4.	IV	25.0
5.	V	25.0
6.	VI	25.0
7.	VII	18.0
8.	VIII	16.0
	TOTAL	175.0

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 analog and digital circuits and systems with emphasis on experimentation and hands on work.

2. Understand mathematical modeling techniques, nurture analytical and computational skills to provide engineering solutions in the areas of communication, signal processing, controls and networking with a scope for innovative practices.

3. Realize the importance of industry challenges, professional ethics, environmental issues, management principles, entrepreneurship, societal obligations and continuing education.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for Physics Cycle of I Year B.E.

SEMESTER: I

Sl. No	Subject code	Course title	Teaching department	Credits				Contact hours	Marks			Exam duration in hrs
				L	T	P	Total		CIE	SEE	Total	
1	MA110	Engineering Mathematics-I	Maths.	3	1	0	04	05	50	50	100	03
2	PH110/ PH210	Engineering Physics	Physics	3	1	0	04	05	50	50	100	03
3	CV110/ CV210	Engineering Mechanics	Civil	4	0	0	04	04	50	50	100	03
4	ME110/ ME210	Elements of Mechanical Engineering	Mech/IP	4	0	0	04	04	50	50	100	03
5	PH12L/ PH22L	Engineering Physics Laboratory	Physics	0	0	1.5	1.5	03	50	-	50	-
6	HU110/ HU210	Functional English	Humanities	2	0	0	02	02	50	-	50	-
7.	HU120/ HU220	Kannada	Humanities	-	-	-	-	02	50	-	50	-
				Total credits			**19.5**	**25**	**Total marks**		**550**	-

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for Chemistry Cycle of I Year B.E.

SEMESTER: II

Sl. No	Subject code	Course title	Teaching department	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	MA210	Engineering Mathematics–II	Maths.	3	1	0	04	05	50	50	100	03
2	CH110/ CH210	Engineering Chemistry	Chemistry	3	1	0	04	05	50	50	100	03
3	EE110/ EE210	Elements of Electrical and Electronics Engineering	E&EE/E&C	4	0	0	04	04	50	50	100	03
4	CS110/ CS210	Programming for Problem Solving	CS&E / IS	4	0	0	04	04	50	50	100	03
5	ME120/ ME220	Engineering Graphics and Design	Mech./IP	1	0	2	03	05	50	50	100	03
6	CH12L/ CH22L	Engineering Chemistry Lab	Chemistry	0	0	1.5	1.5	03	50	-	50	-
7	CS12L/ CS22L	Programming Laboratory	CS&E / IS	0	0	1.0	1.0	02	50	-	50	-
				Total credits			**21.5**	**28**	**Total marks**		**600**	-

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for II - Year B.E.

SEMESTER: III

Sl. No	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	MA311	Fourier Series, Integral transforms and Applications	BS	4	0	0	04	04	50	50	100	03
2	EC310	Circuit Theory and Analysis	PC	3	1	0	04	05	50	50	100	03
3	EC320	Sensors and Actuators	PC	3	1	0	04	05	50	50	100	03
4	EC330	Analog Electronic Circuits	PC	3	0	1	04	05	50	50	100	03
5	EC340	Digital System Design	PC	3	0	1	04	05	50	50	100	03
6	EC350	Communication – I	PC	4	0	0	04	04	50	50	100	03
7	EC36L	Hardware System Integration and Simulation Lab	PC	0	0	1	01	02	50	-	50	-
				Total credits			25	30	Total marks		650	-

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for II - Year B.E.

SEMESTER: IV

Sl. No	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	MA411	Probability, Random variables and Stochastic processes	BS	4	0	0	04	04	50	50	100	03
2	EC410	Linear Integrated Circuits	PC	3	0	1	04	05	50	50	100	03
3	EC420	Microcontrollers and Applications	PC	3	0	1	04	05	50	50	100	03
4	EC430	Signals and Systems	PC	3	1	0	04	05	50	50	100	03
5	EC440	Communication Channels	PC	4	0	0	04	04	50	50	100	03
6	EC450	Engineering Electromagnetics	3	3	1	0	04	05	50	50	100	03
7	EC46L	Communication Lab – I	PC	0	0	1	01	02	50	-	50	-
				Total credits			25	30	Total marks		650	-

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Scheme of Teaching and Examination for III - Year B.E.

SEMESTER: V

Sl. No	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	EC510	Linear Algebra and Applications	BS	3	1	0	04	05	50	50	100	03
2	EC520	Communication - II	PC	4	0	0	04	04	50	50	100	03
3	EC530	Microwave and Antennas	PC	4	0	0	04	04	50	50	100	03
4	EC540	Control Systems	PC	3	1	0	04	05	50	50	100	03
5	EC550	Digital Signal Processing	PC	3	1	0	04	05	50	50	100	03
6	EC560	Operating Systems	PC	3	0	0	03	03	50	50	100	03
7	EC57L	Digital Signal Processing Lab	PC	0	0	1	01	02	50	-	50	-
8	EC58L	Communication Lab – II	PC	0	0	1	01	02	50	-	50	-
				Total credits			25	30	Total marks		700	-

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Scheme of Teaching and Examination for III - Year B.E.

SEMESTER: VI

Sl. No	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	EC610	Mobile Communication	PC	3	1	0	04	05	50	50	100	03
2	EC620	Computer Networks	PC	3	0	1	04	05	50	50	100	03
3	EC630	CMOS VLSI Circuits	PC	3	0	1	04	05	50	50	100	03
4	EC640	Optical Fiber Communication	PC	3	1	0	04	05	50	50	100	03
5	EC65X	Elective – I	PE	3	0	0	03	03	50	50	100	03
6	EC66X	Elective – II	PE	3	0	0	03	03	50	50	100	03
7	EC67L	Design and Implementation Lab	PC	0	0	1	01	02	50	-	50	-
8	HU68S	Foreign Language	HU	2	0	0	02	02	50	-	50	-
				Total credits			25	30	Total marks		700	-

CODE	Elective – I
EC651	Data Structures and Algorithms
EC652	JAVA Programming
EC653	Python Programming
EC654	Information Theory and Coding
EC655	Multimedia Communication

CODE	Elective – II
EC661	Robotics and Computer Vision
EC662	Digital Image Processing
EC663	MEMS
EC664	Advanced Digital Signal Processing
EC665	Machine Learning

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Scheme of Teaching and Examination for IV - Year B.E.

SEMESTER: VII

8	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	EC710	Entrepreneurship and Management	PC	3	0	0	03	03	50	50	100	03
2	EC720	Power Electronics	PC	3	0	1	04	05	50	50	100	03
3	EC73X	Elective- III	PE	3	0	0	03	03	50	50	100	03
4	EC74X	Elective -IV	PE	3	0	0	03	03	50	50	100	03
5	EC75P	Project work Phase-I	P	0	0	3	03	03	100	-	100	-
6	EC76S	Moocs or Swayam Certified Course / Physical Activities	S	0	0	2	02	02	50	-	50	-
				Total credits			18	19	Total marks		550	-

CODE	Elective- III
EC731	Automotive Electronics
EC732	Nano Science and Technology
EC733	Satellite Communication.
EC734	Quantum Communication and Computing
EC735	Bio-medical Signal Processing.
EC736	E-Waste Management.

CODE	Elective- IV
EC741	Internet Of Things. (IOT).
EC742	Storage Area Network.
EC743	Cryptography and Network Security.
EC744	Artificial Intelligence. (AI)
EC745	Advanced Embedded Systems.
EC746	Electronics Systems Design and Manufacturing

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Scheme of Teaching and Examination for IV - Year B.E.

SEMESTER: VIII

Sl. No	Subject code	Course title	Type	CREDITS				Contact hours	Marks			Exam duration in hrs
				L	T	P	TOTAL		CIE	SEE	Total	
1	EC810	Mixed Mode VLSI Design	PC	3	1	0	04	05	50	50	100	03
2	EC82X	Elective –V	PE	3	0	0	03	03	50	50	100	03
4	EC83P	Project work Phase-II	P	0	0	7	07	07	70	30	100	03
5	EC84P	Publication / Industry Course	S	0	0	2	02	02	50	-	50	-
				Total credits			16	16	Total marks		350	-

CODE	Elective –V
EC821	Digital Compression Techniques.
EC822	Low Power VLSI Design.
EC823	Wireless Sensor Networks.
EC824	Wavelet Transform.
EC825	Hybrid Vehicles.
EC826	Mobile Computing.

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 Course (HS)	2					2			4	2 %
Basic Science Course (BS)	9.5	9.5	4	4	4				31	17.71%
Engineering Science Courses (ES)	8	12							20	11.42%
Professional Core Course (PC)			21	21	21	17	7	4	91	52.00 %
Professional Elective Course (PE)						6	6	3	15	8.57%
Open Elective Course (OE)										0
Project / Mini Project (P)							3	7	10	5.71 %
Seminar – Internship (S)							2	2	4	2 %
Non Credit Mandatory Course (NC)										0
Total Credits	19.5	21.5	25.0	25.0	25.0	25.0	18.0	16.0	175	

EC 310: Circuit Theory and Analysis

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 310	Circuit Theory and Analysis	4	0	0	4	50	50	100

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

1. Explain network terminologies, theorems and functions.
2. Apply various techniques to solve the given circuit problems.
3. Analyze the given network based on mesh / nodal methods, Fourier techniques and two port parameters.
4. Develop the solutions for network problems.
5. Demonstrate the skill sets using software tools for simulation of circuit problems.

UNIT 1

Basic concepts: Introduction, Network terminologies, Review of KVL and KCL, Energy sources – ideal and practical, Source Transformations, 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.

11 Hours

UNIT 2

Network Theorems: Superposition theorem, problems. Thevenin's theorem as applied to AC and DC circuits, Maximum power transfer theorem as applied to DC and AC circuits, Millman's theorem, applications and problems. **10 Hours**

UNIT 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, 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. **10 Hours**

UNIT 4

Circuit Analysis using Laplace Transforms (LT) and Fourier Series (FS):Review of LT, 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.

Applications of Fourier techniques to circuit analysis, Waveform symmetry, Line spectrum, Waveform synthesis Effective value and power, problems, Application of FS in circuit Analysis. **11 Hours**

UNIT 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 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. **10 Hours**

Self-Learning Component:

Source Shifting techniques and problems, Norton's theorem as applied to DC and AC circuits and its applications, Maximum impedance conditions with C, L, and f variable for parallel resonance circuit, Circuit analysis with LT using convolution integral and its applications. Inter connections of two-port networks.

Text Books:

1. **J. David Irwin, Robert M Nelms**, "*Engineering Circuit Analysis*", 10th Edition, Wiley India Pvt. Ltd, Reprint 2013.
2. **Charles K Alexander, Mathew N. O. Sadiku**, "*Fundamentals of Electric Circuits*" Edition, McGraw Hill Education (India) Pvt. Ltd New Delhi, Reprint 2016.
3. **M.E.VanValkenburg:** "*Network Analysis*", 3rd Edition, Pearson/ PHI, Reprint 2006.
4. **D. Roy Choudhury:** "*Networks and Systems*", New Age International, Reprint 2005.

E-Resource:

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_US

EC 320: Sensors and Actuators

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 320	Sensors and Actuators	4	0	0	4	50	50	100

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

1. Explain the characteristics of electrical and electronic measuring instruments.
2. Illustrate the working principles of transducers, sensors and actuators.
3. Develop and exemplify basic programming skills in Virtual Instrumentation.
4. Design and implement a system using sensor and instrumentation configuration.
5. Demonstrate the skill set using modern tool for simulation of virtual instrumentation.

UNIT 1

Instrumentation System: Introduction, Input output configuration, Generalized functional elements, Advantages of electronic measurement, Errors in measurement, Gross errors and systematic errors, Absolute and relative errors, static characteristics, dynamic characteristics, calibration and standards-process of calibration. **10 Hours**

UNIT 2

Transducers: Introduction, Electrical transducers, Selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges, Resistance thermometer, Thermistor, Inductive transducer, Capacitive transducers, Differential output transducers and LVDT. Piezoelectric transducer, photoelectric transducer, Photovoltaic transducer. Temperature transducers. Basics of pressure measurement- Thin plate Diaphragms, Corrugated Diaphragms and Capsules, Bourdon tube elements. **11 Hours**

UNIT 3

Virtual Instrumentation: Introduction, advantages, data types, graphical system design, modular programming, vis and sub-vis loops, arrays, clusters, plotting data, customizing graphs and charts, case structures, formula nodes, timed structures, data acquisition **11 Hours**

UNIT 4

Sensors: Introduction, principles, classification, characterization, Smart sensors: Introduction Primary sensors Information coding/ processing, Data communication, automation. Introduction to MEMS and Microsystems, Microsystems and Microelectronics Multidisciplinary nature of microsystem design and manufacture applications of microsystems, Micro sensors, Humidity and Moisture Sensors**.**

10 Hours

UNIT 5

Actuators: Functional components of an actuator, Performance Characteristics of Actuators, Thermo mechanical Actuators, Optical Actuators, Capacitive Actuators, Actuator as a system component, Intelligent & Self sensing actuators, microactuators, MEMS with microactuators, Application examples. **10 Hours**

Self-Learning Component:

Wireless sensor and actuators, Robotic sensors and actuators, automation using sensors and virtual instrumentation, polymeric sensors.

Text Books:

1. **D.V.S. Murthy**: "*Transducers and Instrumentation"*, 2nd Edition, PHI Ltd., 2014.
2. **Tai-Ran Hsu**: "*MEMS & Microsystems Design Manufacture and nanoscale Engineering"*, 2nd Edition, Tata McGraw Hill, 2008.
3. **Jovitha Jerome**: "*Virtual Instrumentation using LabVIEW"*, PHI Ltd., 2010.
4. **Hartmut Janocha**:"*Actuators Basics and Applications***"**, Springer publication 2013.

E-Resource:

1. https://nptel.ac.in/courses/108105064/34
2. https://nptel.ac.in/courses/112103174/3

EC 330: Analog Electronic Circuits

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 330	Analog Electronic Circuits	3	0	1	4	50	50	100

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

1. Explain the working of transistors biasing and amplifier circuits.
2. Analyze the amplitude and frequency responses of Linear Integrated circuits
3. Design feedback circuits using BJTs and FETs
4. Design and develop the Linear Integrated circuits using BJT s and FET's.
5. Demonstrate the effect of feedback in amplifiers using various topologies.

UNIT 1: BJT AC analysis

BJT modeling, re model, hybrid model, hybrid π model, CE fixed bias, Voltage divider bias and Emitter bias configurations, Emitter follower, CB Configuration, Cascaded systems, Effects of Rs and RL. **08 Hours**

UNIT 2: MOSFET and FET AC analysis

Small Signal model of MOSFET, MOSFET Common source, Common drain and Common Gate amplifiers, MOSFET High frequency model, Model of JFET, Basic JFET amplifiers. **08 Hours**

UNIT 3: BJT and MOSFET Frequency response

General frequency considerations, Low frequency response of BJT and MOSFET amplifiers, Miller effect capacitance, High frequency response of BJT and MOSFET amplifiers, Multistage effects. **08 Hours**

UNIT 4: Feedback and oscillators

Concept of feedback, Feedback topologies, Effect of Negative feedback on performance of amplifier, Basic principle of oscillators, RC, LC and Crystal oscillators. **08 Hours**

UNIT 5: Power amplifiers

Class A series fed and transformer coupled class A power amplifier, Class B and Class AB power amplifiers, Harmonic distortion. **08 Hours**

Self-Learning Component:

Darlington Pair, Feedback Pair, Cascode Amplifier, Single Stage IC MOSFET Amplifier, Practical feedback Circuits, Class C, D and S Power amplifiers.

Text Books:

1. **Robert Boyelstad:** "*Electronic Devices and circuit theory*", 11th Edition, Pearson, 2015.
2. **Donald A Neamen:** "*Microelectronics Circuit Analysis and Design*", McGraw-Hill Education, 4th Edition, 2009.
3. **Adel S Sedra and Kenneth C Smith: "***Micro Electronic circuits; Theory and applications*", 7th Edition, Oxford University Press, 2017.
4. Dr U B Mahadevaswamy, "*Analog Electronics Circuits*", Sanguine Publications, Revised Edition 2010.

E-Resource:

1 EBook: http://www.freebookcentre.net/Electronics/Analog-Circuits-Books.html

2 Video Lecture: http://nptel.ac.in/courses/108102095/

List of Experiments:

1. Design and testing of BJT biasing circuits.
2. Design and testing of single stage RC – coupled CE amplifier.
3. Design and testing of Emitter follower.
4. Design and testing of CB amplifier.
5. Design and testing of two stage RC – coupled CE amplifier.
6. Design and testing of single stage FET CS amplifier.
7. Design and testing of RC low pass and high pass circuits.
8. Design and testing of negative feedback amplifier.
9. Design and testing of phase shift and Wein bridge oscillators.
10. Design and testing of Hartley and Colpitts oscillators.

EC 340: Digital System Design

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 340	Digital System Design	3	0	1	4	50	50	100

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

1. Explain the various data related operations in digital systems.
2. Apply various reduction techniques to Simplify Boolean expressions
3. Formulate and analyze simple processing systems.
4. Design combinational and sequential circuits
5. Design and demonstrate the working of digital system
6. Demonstrate the skill sets using EDA tool for analysis and simulation of digital system.

UNIT1:

Boolean algebra, Logic gates and Simplification of Boolean Functions-Basic gates, Universal gates, Boolean theorems, Sum of Products (SOP) and Product of Sums (POS) methods of simplification, Simplification of Boolean functions using K-map and variable entered map. **08 Hours**

UNIT 2:

Design of combinational logic using MSI components- Design of parallel adder/subtractor, Look ahead carry adder, BCD adder, Multiplexer, Demultilexer, Decoder, Encoder, Priority Encoder , Magnitude comparator. **08 Hours**

UNIT 3:

Flip flop, Shift registers and Counters- Introduction to different types of flip-flops, Registers, shift registers, Universal shift registers, and Counters- ripple counter, design of synchronous counters for arbitrary sequence. **08 Hours**

UNIT 4:

Register-transfer logic - Inter register transfer, Arithmetic, logic and shift micro operation, conditional control statements, Instruction codes, Design of simple computers. **08 Hours**

UNIT 5:

Processor Logic Design and Control Logic Design- Processor organization, ALU, design of arithmetic circuit, design of logic circuit, design of ALU, status register, Design of shifter, processor unit, Design of accumulator. Control logic design-Control organization, Hardwired control, Micro program control.

08 Hours

SLE Component: Quinine Mc-clusky method, Decimal method of generation of PI, Code converters, Design of synchronous counters using different types of flip flops, Memory unit, Design of simple digital system.

Text Books:

1. **Donald Givone,**"*Digital principles and design*", TMH-2008 Edition.
2. **Morris Mano, Charles Kime, "***Logic and computer design fundamental*", Pearson New 4th
3. International Edition, 2017.
4. **Thomas L. Floyd and R.P. Jain**, "*Digital Fundamentals*", 8th Edition, Pearson education,
5. 2009.
6. **Dr R D Sudhaker Samuel**:**"***Logic Design***",** Sanguine publications, 2008.

E-Resource:

1. http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2. Video Lecture: http://nptel.ac.in/courses/117105080/

LAB COMPONENT

List of experiments

1. Simplify the given Boolean expression and to realize them using logic gates/universal gates.
2. Design and implementation of half/full adder and subtractor using logic gates/universal gates.
3. Design and implementation of i) parallel adder/subtractor and ii) BCD-to-excess-3 code converter and vice versa.
4. Design and implementation of code conversion from gray-to-binary and vice-versa.
5. Design and implementation of full adder/subtractor and code converters using i) multiplexer and ii) decoder IC's.
6. Design and implementation of one bit, two bit magnitude comparators.
7. Implementation of i) priority encoders and ii) 7 segment LED decoder driver circuit.
8. Implementation and verification of truth table for J-K flip-flop, Master-slave J-K flip-flop, D flipflop and T flip-flop.
9. Design and implementation of Mod-N synchronous counter using J-K flip-flops.
10. Design and implementation of shift register to function as i) SISO, ii) SIPO, iii) PISO, iv) PIPO, v) Shift left and vi) shift right operation. vii) Ring counter and viii) Johnson counter.

EC 350: Communication - I

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 350	Communication - I	4	0	0	4	50	50	100

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

1. Explain the principles of communication systems.
2. Apply theorems and transforms for computing parameters of communication systems
3. Analyze the performance of modulation systems, transmission media and multiplexing techniques.
4. Build and demonstrate communication systems using discrete components and simulation tools.

UNIT 1

Introduction to Communication Systems: Significance of Electronic Communication Systems, History and development of communication systems, Types of communication systems, Wired and wireless communication, Electromagnetic spectrum, Bandwidth, Modulation and Multiplexing, Gain Attenuation and Decibels, Tuned circuits, Filters, Fourier theory, time and frequency domains

12 hours

UNIT 2

Communication Mediums: Types of mediums**,** Parallel wire, twisted pair and coaxial cables, Waveguides, Optical fibers, Principles of wireless transmission, Microwave communication

10 hours

UNIT 3

Fundamentals of Modulation **:** Fundamentals of Amplitude and frequency modulation, Basics of Digital communication, Data conversion, Pulse modulation, PCM

10 hours

UNIT 4

Transmission Lines: Distributed parameters, transmission line equation and solutions, Line constants, infinite lines, distortion less lines and conditions, reflections, open circuit and short circuit lines, reflection co efficient, secondary lines, line at RF, VSWR, Impedance matching **10 hours**

UNIT 5

Multiplexing and Demultiplexing : Types of Multiplexing, FDM,TDM, PCM-TDM, Transmission of Digital data over analog channels, ASK,FSK,PSK, Types of Modems. **10 hours**

Self-Learning Component:

Recent trends and current publications: Handbook of Advanced Communication Systems

IEEEXplore: IEEE communications Magazines- (Current Issue 2018)

https://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=35

Text Books:

1. **Louis E Frenzel:** *"Principles of Electronic Communication systems"*, 3rd Edition, TMH, 2008
2. **Wayne Tomasi:** *"Electronic Communication Systems"*, 5th Edition, Pearson education, 2007

E-Resource:

1. https://www.youtube.com/watch?v=PMtIG_ZR2z
2. https://www.youtube.com/watch?v=M9IbVYetVDE
3. https://www.youtube.com/watch?v=Jj5da92401U

EC 36L: Hardware Systems Integration & Simulation Lab

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 36L	Hardware Systems Integration & Simulation Lab	0	0	1	1	50	-	50

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

1. Explain hardware and software sub-systems required for the simulation.
2. Configure the hardware platform for simulation, practice basic commands at different levels of hierarchy.
3. Demonstrate the working of analog and digital circuits using simulation tools and interpret the results

   (NOTE : This lab to be conducted in 2 parts : Hardware and software expts.)

PART 1: Hardware Experiments

1. Introduction to PC Hardware and its Technology (Manufacturers and vendors)
2. PC Assembly and Trouble shooting
3. Disk Partitioning and Formatting
4. OS Installation (Mono-boot / Dual-boot systems)
5. Virtualization
6. Introduction to PC Networking (Hub/switches/Router: wired and wireless)
7. PCB Design and Fabrication

PART 2: Software Experiments

1. Installation and configuring the software required for simulation Lab
2. simple circuit simulation (Network Theorems)
3. simple Amplifier circuits
4. Digital Circuits

IV Semester

EC 410: Linear Integrated Circuits

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 410	Linear Integrated Circuits	3	0	1	4	50	50	100

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

1. Explain the operation of linear integrated circuits and its applications.
2. Analyze linear integrated circuits to obtain the voltage and current responses at different points and the frequency response of the circuits.
3. Design a linear integrated circuit for the given specification by applying the linear integrated circuit concepts.
4. Demonstrate a given application / problem statement using linear ICs.
5. Demonstrate the skill sets using EDA tool for analysis and simulation of linear integrated circuits.

UNIT 1: night

Op-Amp Basics, DC and AC Amplifiers: Basic Op-amp circuit, IC 741Op-amp, Input/output impedances, Slew-rate & Frequency Limitations, Direct-coupled voltage followers, Inverting and Non-inverting amplifiers, Summing and Difference amplifiers, AC voltage follower, AC Inverting and Non-inverting amplifiers. **08 Hours**

UNIT 2: afternoon

Op-Amp Linear Applications: Instrumentation amplifier, V to I and I to V Converters, Integrator and Differentiator, Active filters. **08 Hours**

UNIT 3: night

Signal Conditioning and Data Converter circuits: Precision half-wave and full-wave rectifiers, Clipping and Clamping circuits, Peak detectors, Sample and Hold circuits, A to D and D to A Converters. **08 Hours**

late night

afternoon

UNIT 4:

Op-Amp Nonlinear Applications: Comparators, Schmitt trigger circuits, Square/Rectangular and Triangular wave generators, LOG and ALOG amplifiers. **08 Hours**

tommorow from 6:00 revision

UNIT 5:

Voltage Regulators and 555Timer: Fixed and Adjustable voltage regulators, Switching regulators.555 Timer as Monostable and Astable Multivibrators, applications, Introduction to Phase-locked loops (PLL). **08 Hours**

before afternoon

Self-Learning Component:

Peaking amplifier, Applications of instrumentation amplifier: Temperature Indicator, Temperature Controller, Light Intensity meter, Analog weight scale, Measurement of flow and thermal conductivity, Low voltage DC meter, Diode match finder, Zener diode tester, Summing differentiator and double integrator, state variable filters, Switched capacitor filter, IC sample and hold circuit, window comparator, Power amplifier and overload detector, Light transmission measurement , Function generator, Step down regulator using LM3578, Digital storage oscilloscope.

Text 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 ,2015

3 **James M. Fiore:** "*Operational Amplifiers & Linear Integrated Circuits: Theory and Application"* Version 3.0.1, 31 August 2016.

4 **D. Roy Choudhary:** "*Linear Integrated Circuits*", 4th Edition, 2011.

E-Resource:

1 EBook: https://docs.google.com/file/d/0B21HoBq6u9TsbG5WdjNZeGwtMWs/preview

2 Video Lecture: http://nptel.ac.in/courses/108106068/

Lab Component

List of Experiments

1. Design and testing of Op-amp DC 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 AC amplifiers: Inverting amplifier, Non- inverting amplifier and Voltage follower.
4. Design and testing of Op-amp integrator.
5. Design and testing of Op-amp differentiator.
6. Design and testing of Butterworth's Low pass and High pass filters.
7. Design and testing of Band pass and Band Elimination filters.
8. Design and testing of Schmitt Trigger Circuits.
9. Design and testing of Op -Amp Triangular and Rectangular Waveform Generators.
10. Design and testing of Voltage regulator.
11. Design and testing of 555 Timer Astable Multi-vibrator.

EC 420: Microcontrollers and Applications

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 420	Microcontrollers and Applications	3	0	1	4	50	50	100

Course outcomes: At the end of the course, the student shall be able to

1. Explain the internal architecture, hardware and instruction set of microcontrollers
2. Apply logic to write assembly and embedded C code for the microcontrollers
3. Design applications based on microcontrollers
4. Demonstrate the microcontrollers based applications using EDA tools.

UNIT 1: finished

8051 Microcontroller:- Architecture, 8051 hardware, i/o and o/p pins, ports and port circuits, external memory, counters and timers, serial communication. **08 Hours**

UNIT 2: finished

Addressing modes & instructions: - Addressing modes, external data moves, code memory read only data moves, PUSH & POP op-codes, data exchanges, arithmetic, logical, jump and call instructions. **08 Hours**

UNIT 3: revision night

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. **08 Hours**

UNIT 4: night

Interfacing Applications: - Interfacing keyboard, LCD, ADC, DAC, Stepper motor & DC motor, 7 segment displays, Elevator. **08 Hours**

UNIT 5:

afternoon

Introduction to ARM Cortex-M processors: Introduction to ARM cortex-M3, Advantages of the Cortex –M processors, Applications of the ARM cortex-M processors development

Architecture: Introduction to the architecture, Programmer's model, Behavior of the application program status word, Barrel shifter, System control block, Debug, Reset and reset sequence

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. **08 Hours**

Self learning component: Study architecture and programming of ARM 7 processor.

Text Books:

1. **Kenneth J Ayala :** "*The 8051 Microcontroller Architecture, Programming and Application* " - 2nd Edition 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.
4. **Andrew N.Sloss**, **Dominic Symes and Chris Wright**-'*ARM system developer Guide Designing and Optimizing System Software'* Elsevier 2004.

E Resources:

1.http://infocenter.arm.com/help/topic/com.arm.doc

2. http://www.keil.com

3. *https://swayam.gov.in*

Lab Component

List of experiments:

Software programs: To be implemented on 8051 microcontroller

1. Problems related with data transfer and exchange.
2. Problems related with arithmetic and logical operations.
3. Problems related with programming timers in all modes with and without interrupts.
4. Problems related with programming serial communication with and without interrupts.
5. Program related with handling external interrupts.

Hardware programs: To be implemented on 8051 and ARM CORTEX-M3

(Using Embedded C)

1. Interface LCD.
2. Interfacing of matrix keypad.
3. Interfacing of ADC and DAC.
4. Interfacing of multi digit 7 segment displays.
5. Interfacing of stepper motor and D C motor.

EC 430: Signals and Systems

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 430	Signals and Systems	4	0	0	4	50	50	100

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

1. Explain the classification of signals and their representation in time and frequency domain.
2. Analyze continuous and discrete time LTI systems, their properties in time and frequency domains.
3. Develop the solutions for problems related to signals and systems.
4. Demonstrate skill sets related to software tools in the analysis and simulation of signals and systems.

UNIT 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. **08 Hours**

UNIT 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. **12 Hours**

UNIT 3: Fourier analysis of Continuous time signals and LTI systems night

Introduction, Complex sinusoids and frequency response of LTI systems, Fourier representation for four classes of signals, Fourier series representation of Continuous time periodic signals (CTFS), Convergence of Fourier Series, Properties of Amplitude and Phase spectra, 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. **10 Hours**

UNIT 4: Fourier analysis of discrete time signals and LTI systems night

Fourier representation of Periodic signals in discrete time (DTFS), Properties, 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. **10 Hours**

UNIT 5: Z- transforms and Applications now

Introduction to z-transform, ROC and its 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. **10 Hours**

Self-learning components: Current research literature in signal processing and system theory.

Text Books:

1. **Simon Haykin and Barry VanVeen:** "*Signals and systems*" – Wiley India Edition, Second Edition, 2008.
2. **Alan V Oppenheim, Alan S Wilsky, S Hamid Nawab**: "*Signals and system*", 2 nd Edition, PHI/Pearson Education, 2004.
3. **H P Hsu:** "*Signals and systems*", 2 nd Edition, The McGraw Hill, 2008.

E-Resource

1. https://nptel.ac.in/courses/1171040741.
2. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/
3. https://www.youtube.com/watch?v=s8rsR_TStaA

EC 440: Communication Channels

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 440	Communication Channels	4	0	0	4	50	50	100

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

1. Explain the basic mathematical models of communication channels.
2. Analyze wired and wireless channels.
3. Design inter-links (channels) between source and destination based on required specifications and develop appropriate solutions to problems.
4. Investigate signal propagation in communication channels.
5. Use modern tools to solve and demonstrate channel problems and develop concrete documents.

UNIT 1:

Transmission lines as wired channels: Transmission lines at low frequencies: Types, distributed parameters, transmission line equation and solutions, Secondary line constants, input impedance, infinite lines, distortion less lines and conditions, reflections, open circuit and short circuit lines, reflection co efficient, reflection and insertion loss Transmission lines at RF: Line constants, SWR, Relationship between SWR and reflection coefficient, loss less lines as impedance matching sections, stub matching, OC and SC lines, Smith chart principles and applications. **12 Hours**

UNIT 2:

Planar Transmission lines: Introduction, strip lines ,micro strip lines, parallel strip lines, co-planar strip lines, shielded strip lines, losses in strip lines, strip line parameters. **10 Hours**

UNIT 3:

Rectangular and circular wave guides: Introduction to waveguides, Rectangular and circular waveguides, Modal theory- TE and TM waves, Impossibility of TEM waves, Waveguide parameters, directional coupler **10 Hours**

UNIT 4:

Fibers as Communication channels: Introduction to fibers, Pulse broadening in fibers, information capacity, Optical and electrical bandwidth, Single mode fibers, ISI, information capacity. **10 Hours**

UNIT 5:

Wireless channels: Noise and interference in Communication Channels: Internal noise, external noise, noise modeling, frequency (orthogonal) domain representation, carrier to noise ratio, probability error, Gaussian noise (white noise) representation. Power spectral density of Noise, BER, fading of signals, long term, short term fading and Rayleigh fading. **10 Hours**

Self - Learning Components: Recent advances from latest papers, magazines and journals (10 Marks compulsory question in SEE exam).

Text Books:

1. **John D Ryder:** "*Fields lines and waves*", PHI, 2Edition, 2002.
2. **Gerd Keiser:** "*Optical Fiber Communication*", MGH, 4th Edition, 2008.
3. **Taub and Schiling:** "*Communication Systems*", MGH, 2008.

E-Resource:

1. https://www.researchgate.net/publication/293439794
2. https://onlinelibrary.wiley.com/doi/full/10.1002/047134608X.W2004

EC 450: Engineering Electromagnetics

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 450	Engineering Electromagnetics	4	0	0	4	50	50	100

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

1. Explain different types of fields and charge distributions.
2. Apply vector calculus to determine electric and magnetic fields in different configurations.
3. Analyze the static and time varying fields and determine its behavior in different medium.
4. Develop solutions for electromagnetic problems and interpret the results.
5. Demonstrate the skill sets using modern tools to solve EM problems.

UNIT 1: 27th afternoon

Steady Electric Fields : 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 Hours**

UNIT 2: 28th morning

Electric Work, Energy and Potential: 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. **10 Hours**

UNIT 3: 29th afternoon

Steady Magnetic Fields: Poisson's and Laplace Equations, Uniqueness Theorem, Calculating capacitance using Laplace's Equation ,Magnetic field & its properties, Biot Savart's Law, Computation of H using BSL, Ampere's Circuital Law, Computation of H using ASL, Curl and Stokes Theorem, Magnetic flux and flux density, Scalar and Vector Potentials, Magnetic forces, Boundary conditions for magnetic field. **10 Hours**

UNIT 4: 30th morning

Time Varying Fields: Introduction to Time Varying fields, Faraday's equations, Displacement current, Field relations for Time Varying Electric and Magnetic fields, Maxwell's Equations, and Boundary conditions for time varying fields. **10 Hours**

UNIT 5: 30th afternoon

Uniform Plane Wave: Uniform plane waves, General equations, UPW in free space & various media, Power in EM waves & Poynting Theorem**,** Polarization of UPW. **10 Hours**

SLE: Conductor and Dielectric Properties, Concept of Capacitance, Energy stored in capacitance, Magnetic Materials.

Text Books:

1. **Matthew N.O. Sadiku, S.V. Kulkarni:** *"Principles of Electromagnetics"*, 6th Edition, Pearson Education, 3rd Impression, 2016.
2. **William A Hayt, John A Buck, M jaleel Akhtar :** *"Engineering Electromagnetics"*, 8th Edition, McGraw-Hill, 2014.
3. **Karl E. Lonngren, Sava V. Savov:** *"Fundamentals of Electromagnetics with MATLAB"*, 2nd Edition, SciTech Publications, 2007.
4. **David K Cheng**: *"Field and Wave Electromagnetics"*, 2nd edition, Perason Education Asia, 2001.
5. **E.C.Jordan and K.G.Balmain**: *"Electromagnetic Waves and Radiating Systems"*, 2nd Edition, PHI Publications, 1995.

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

EC 46L: COMMUNICATION LAB-1

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 46L	COMMUNICTION LAB-1	0	0	1	1	50	-	50

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

1. Design & demonstrate the working of passive filters, plot frequency response and interpret the results.
2. Demonstrate few analog, pulse modulation principles and draw important waveforms
3. Construct and demonstrate working of amplifiers, oscillators and wave form generators
4. Conduct experiments on various communication passive circuits and draw conclusions on the results.

List of Experiments:

1. Passive filters- LP and HP RC filters
2. AM modulation
3. FM modulation
4. Pulse modulation –PAM, PWM
5. RF tuned amplifier
6. PLL
7. Oscillators- RC, Hartley & Colpitts
8. Waveform generators-Sine, Square, Pulse & Triangular
9. Insertion loss measurements
10. Emphasis circuits

SLE components

11. Characteristic impedance and image impedance measurements
12. Frequency multipliers and dividers

V Semester

EC 510: Linear Algebra and Applications

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 510	Linear Algebra and Applications	4	0	0	4	50	50	100

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

1. Define and explain fields, vector spaces and inner product spaces.
2. Obtain the solution for the systems of linear equations.
3. Analyze and solve the problems on the bases, dimensions and orthogonalization of vectors
4. Apply principles of matrix algebra to linear transformations and canonical forms.
5. Engage in independent study as a member of a team and make effective presentation on the simulations & applications of Linear Algebra.

UNIT 1:

Linear equations: Fields; system of linear equations, and its solution sets; elementary row Operations and echelon forms; Gauss elimination method; LU-factorization. **10 Hours**

UNIT 2:

Vector spaces: Vector spaces; subspaces; bases and dimension; coordinates; summary of row equivalence; computations concerning subspaces. **10 Hours**

UNIT 3:

Linear Transformations: Linear operations, Linear transformations; bilinear transformation, representation of transformations by matrices; Change of basis, Null Space and Range Space of Linear Transformation, Four Fundamental Subspaces of a Transformation. **12 Hours**

UNIT 4:

Canonical Forms: Eigen Value, Eigen Vector, Characteristic values and Characteristic Polynomial; annihilating polynomials; invariant subspaces; Jordan canonical form. **10 Hours**

UNIT 5:

Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projection,Gram-Schmidt process, Singular value Decomposition. **10 Hours**

SLE: Applications of linear algebra: Correlation, FFT and Convolution using Matrix, Diagonalization of convolution and matrix, Application of LDA, PCA (dimensionality reduction), and SVM.

TEXT BOOKS:

1. **Kenneth Hoffman and RayKunze,** *"Linear Algebra"*,2nd edition, Pearson education,2005.
2. **David C Lay**, *"Linear Algebra and Its Applications"*, 3rd edition, Pearson education ,2003.
3. **Gilbert Strang**,"*Introduction to Linear Algebra"*,5th edition ,Wellesley-Cambridge Press,2016.
4. **Seymour lipschutz**, Marc Lipson "*Linear Algebra*", 6th edition, TataMcgraw-Hill ,2018

E-resources:

1. https://onlinecourses.nptel.ac.in/noc18_ma16
2. https://nptel.ac.in/courses/111106051/
3. https://onlinecourses.nptel.ac.in/noc19_ma06/preview
4. https://onlinecourses.nptel.ac.in/noc17_ma04/preview

EC 520: Communication - II

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 520	Communication – II	4	0	0	4	50	50	100

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

1. Explain and analyze the fundamental concepts of analog communication.
2. Demonstrate the working of different kind of modulation and demodulation circuits.
3. Design and demonstrate modulation and demodulation circuits by using simulation tool for system analysis.
4. Analyze and evaluate various baseband transmission techniques.
5. Involve in independent/team learning, communicate effectively and engage in life-long learning.

UNIT 1:

ANALOG COMMUNICATION: Noise: Source of Noise – External Noise- Internal Noise- Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM). **10 Hours**

UNIT2:

DIGITALCOMMUNICATION: 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 – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM). **10 Hours**

UNIT 3:

WAVEFORM CODING TECHNIQUES: Discretization in time and amplitude. Linear quantizer, quantization noise power calculation, signal to quantization noise ratio, non – uniform quantizer, A law & μlaw 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, MPEG audio coding standard. **11 Hours**

UNIT 4:

DIGITAL BASEBAND TRANSMISSION: Line coding and its properties. NRZ & RZ types, signaling format for Unipolar, 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. Matched filter receiver, derivation of its , impulse response and peak pulse signal to noise, correlation detector decision threshold and error probability for binary Unipolar (on – off), signaling. **11 Hours**

UNIT 5:

SOURCE AND ERROR CONTROL CODING: Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes, convolution codes, viterbi decoding algorithm. **10 Hours**

Text Book:

1. **Wayne Tomasi**, *"Advanced Electronic Communication Systems"*, 6th Edition, Pearson Education, 2009.
2. **Simon Haykin**, *"Communication Systems"*, 4th Edition, John Wiley & Sons, 2004
3. **B. P.Lathi**, *"Modern Analog and Digital Communication Systems"*, 3rd Edition, Oxford University Press, 2007
4. **Martin S.Roden**, "Analog and Digital Communication System", 3rd Edition, Prentice Hall of India, 2002.

E-Resource:

1 https://www.tutorialspoint.com/digital_communication/digital_communication_analog...

2 https://books.google.co.in/books?isbn=8131720926

3 https://www.tina.com/analog-and-digital-communication-systems/

EC 530: Microwave and Antennas

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 530	Microwave and Antennas	4	0	0	4	50	50	100

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

1. Explain and demonstrate knowledge skill set about principles of microwave frequencies, sources, hazards of microwaves and system modeling using s-parameters.
2. Identify different terminologies associated with satellite communication, TV, RADAR, their applications and demonstrate problem solving ability.
3. Design and distinguish different types of antennas, explain principles of antennas and demonstrate problem solving ability.
4. Investigate and analyze different types of antennas, RADARs, demonstrate their application.
5. Work in groups or as an individual, apply modern software tools in micro wave-antenna engineering and prepare proper documentation.

UNIT 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. **10 Hours**

UNIT 2:

Strip lines and MIC: Micro strip lines, parallel strip lines, co-planar strip lines, shielded strip lines, Introduction to MIC, materials, MOSFET fabrication, thin film formation, hybrid circuits. **10 Hours**

UNIT 3:

Radiometry, Introduction to TV signal standards, scanning principles, composite video, VSB transmission, colour transmission, TV cameras, HDTV principles. **10 Hours**

UNIT 4:

Nature of Radar and Radar equations, CW and FM radar, MTI radar, Pulse Doppler Radar, Scanning and Tracking Radars, Radar Displays and Radar Beacons. **10 Hours**

UNIT 5:

Antenna Basics, Antenna Family, Loop, slot, patch, Horn, Helical and Reflector antennas, Antennas for special applications and Antennas for mobile applications. **12 Hours**

Self-Learning Components:

Advance topics in microwave: Strip line fabrications, losses in strip lines, Audio and Video compression standards, Advanced Radar systems, intelligent antennas.

References

1. **Annapoorna Das: "***Microwave engineering*", Paper back 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*", McGraw-Hill, 4th edition, 2004
4. **Kennedy: "***Communication Systems*", paper back 5th edition, McGraw-Hill, 2011
5. **J D Kraus: "***Antennas for all applications*", 2nd edition, McGraw-Hill, 2008.

E-Book

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

EC 540: Control Systems

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 540	Control Systems	4	0	0	4	50	50	100

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

1. Represent the physical system as a mathematical model.
2. Analyze the control systems in time and frequency domains and test for stability using appropriate mathematical tools.
3. Design and test the controllers for transfer function and state-space models.
4. Use modern tools to design, implement, test the controllers and document the results in professional manner.

UNIT 1:

Concept of feedback control, Examples of control systems (Electrical, mechanical, fluid flow) and their dynamical system model, Laplace transform review, Block diagram representation and its algebra, Signal flow graphs and Mason's gain formula, State-space models, Problem solving.

10 Hours

UNIT 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. **13 Hours**

UNIT 3:

Design of classical PI, PD and PID controllers, Root-locus of a basic feedback system and guidelines, dynamic compensation, Design of Phase-lead controller using RL, frequency response, Bode plots, Nyquist stability criterion, stability margins, closed-loop frequency response, design of Phase lead compensator using Bode plots. **13 Hours**

UNIT 4:

State-space design and its advantages, solution of state-equations, full-state feedback control, Controllability, Observability, selection of pole locations for good design, estimator/observer design, combined control law and estimator. **12 Hours**

UNIT 5:

Case studies: An outline of control systems design, satellite attitude control, Maglev control, Inverted Pendulum, Read-write head assembly of hard disk. **4 Hours**

Self-Learning Components: Learn the library functions and tools in OCTAVE/MATLAB/SIMULINK to design and validate the control systems.
Study classical papers on RH test for stability, Nyquist stability criteria.

Text Books:

1. **G. F. Franklin., G. D. Powell., A. E. Naeini,** *"Feedback Control of Dynamic Systems"*, 5th Edition, Pearson Education, 2002.
2. **M. Gopal,** "*Control Systems : Principles and Design*", Tata Mc Graw Hill, 2012.
3. **K. Ogata,** "*Modern Control Engineering*", 4th Edition, Pearson Education, 2006.
4. **S. K. Bhattacharya**, "*Control Systems Engineering*", Pearson Education, 2005.

E-Resource:

1. NPTL Video lectures on Control Systems by Dr. M. Gopal
   https://www.youtube.com/watch?v=vVFDm__CdQw

EC 550: Digital Signal Processing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 550	Digital Signal Processing	4	0	0	4	50	50	100

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

1. Perceive discrete-time signals in the frequency domain and its properties, using discrete Fourier transform.
2. Compute DFT using FFT algorithms.
3. Analyse, design and realize digital filters for the given specifications.
4. Implement the applications of Digital Signal Processing algorithms using computer aided tool.

UNIT 1:

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. **10 Hours**

UNIT 2:

DIT and DIF algorithms for computing DFT and IDFT. Goertzel algorithm, Chirp-Z Transform. 1**0 Hours**

UNIT 3:

Introduction to IIR filters, characteristics of commonly used analog filters, frequency transformations, design of IIR filters from analog filters using IIT and BLT techniques. **10 Hours**

UNIT 4:

Introduction to FIR filters, Design of FIR filters using windowing and frequency sampling techniques. Quantization of filter coefficients, Round-off and finite word length effects in digital filters. **11 Hours**

UNIT 5:

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. **11 Hours**

Self-Learning Components: Recent developments and applications of signal processing,

Text Books:

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

E-Resource:

1. NPTL IEEE Transactions on Signal Processing. Nptel.ac.in

EC 560: Operating Systems

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 560	Operating Systems	3	0	0	3	50	50	100

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

1. Describe principles of computer architecture, structure & functionalities of different Operating Systems.
2. Analyze and evaluate different algorithms with their core functionalities to improve system performance.
3. Describe various memory management techniques with hardware support.
4. Describe resource allocation methods to avoid deadlock.
5. Describe different security threats and different techniques to counter attack them for different file systems.
6. Implement algorithms as a team member for Operating system functions using programming languages, document and give an effective presentation.

UNIT 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**.** **08 Hours**

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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**. **08 Hours**

UNIT 5:

Device Drivers and Inter-process Communication: Devices and their characteristics , input output management, ,Disk scheduling algorithm and policies ,Establishing inter-process communication. **08 Hours**

Self-Learning Components: Case studies of algorithms to improve the core functions of operating system.

Text Books:

1. **D. M. Dhamdhare,** *"Operating Systems – "A Concept based Approach"***,** TMH, 3rd Ed, 2006.
2. **Willaim Stalling,** *"Operating System – Internals and Design Systems"*, Pearson Education, 6th Ed,2009.
3. **Pramod chanrdra** *"An introduction to operating systems concepts and practice "*, PHI, 3rd Ed ,2010
4. **Silberschatz and Galvin,** *"Operating Systems Concepts"*, John Wiley, 8th Edition, 2001.

E-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]

EC 57L: Digital Signal Processing Lab

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 57L	Digital Signal Processing Lab	0	0	1	1	50	50	100

Course outcome: At the end of the course, the student should be able

1. Verify signal processing concepts of time domain and frequency domain using computer.
2. To design, test and simulate FIR and IIR filters on computer.
3. To design, test and simulate adaptive filters on computer.
4. To verify the concepts of Multi rate DSP on computer.
5. To verify the DSP concepts in real time using DSP Processor.

List of Experiments

Lab No.	Experiment
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
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.	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

4.	a) 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 Program 2). Further compute the IDFT using IDIT and IDIF algorithm. b) 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 the set of specifications. (To design should be verified by convolving the input signal with the designed filter coefficients)
5.	a) 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. b) Write a MATLAB code to verify the Low pass Butterworth IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method. c) Write a MATLAB code to implement the Low pass Chebyshev (Type 1) IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.
6.	a) 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 interpolating the signal respectively. b) 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.
7.	Read the data file named ecg2x60.dat from **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.
8.	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.
9.	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.

EC 58L: Communication Lab

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 58L	Communication Lab	0	0	1	1	50	50	100

Course outcome: At the end of the course, the student should be able

1 Apply basic engineering knowledge design, to test and compare different types of filters based on given specifications.

2 Analyze and demonstrate the working principles of different digital modems using discrete components and kits.

3 Compute few performance parameters of filters and modems to draw proper conclusions

4 Work in groups and as an individual to inherent and demonstrate practical knowledge by interaction and communication.

5 Do simulation of experiments using suitable modern tools and verify with practical results & documentation.

List of Experiments:

1. m derived Low Pass Filter (T&Pi type)
2. m derived High Pass Filter (T&Pi type)
3. ASK modulation/de modulation (Using Discrete and Kit)
4. FSK modulation/de modulation (Using Discrete and Kit)
5. BPSK modulation/de modulation (Using Discrete and Kit)
6. T and Pi Attenuators
7. Bridge and Lattice attenuators
8. TDM
9. Microwave antenna experiments
10. Simulation experiments using MATLAB tool kit
    a.PCM
    b. Delta/AD modulation
    c. QPSK
11 SLE component: Transistor/Mixer circuits, DPSK, Dolby coding and 0.3GMSK

VI Semester

EC 610: Mobile Communication

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 610	Mobile Communication	4	0	0	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Apply knowledge of engineering fundamentals to comprehend basic principles and standards of mobile communication systems.
2. Identify, formulate and analyze the various methods for enhancing the cellular system capacity.
3. Explain and analyze different multiple access techniques, path loss models and solutions.
4. Comprehend and explain various techniques of data communication over cellular channels.
5. Use modeling and simulation tools to demonstrate various scenarios in mobile communication.
6. Work effectively as a member or a leader in teams to implement assigned tasks related to advanced topics.

UNIT 1:

Introduction to wireless telecommunication systems and Networks, History and Evolution Different generations of wireless cellular networks 1G, 2g,3G and 4G networks.

Common Cellular System components, Common cellular network components, Hardware and software, views of cellular networks, 3G cellular systems components, Call establishment.

11 Hours

UNIT 2:

Wireless network architecture and operation, Cellular concept Cell fundamentals, Capacity expansion techniques, Cellular backbone networks, Mobility management, Radio resources and power management Wireless network security

GSM and TDMA techniques, GSM system overview, GSM Network and system Architecture, GSM channel concepts, GSM identifiers **11 Hours**

UNIT 3:

GSM system operation, Traffic cases, Cal handoff, Roaming, GSM protocol architecture. TDMA systems CDMA technology, CDMA overview, CDMA channel concept CDMA operations .

10 Hours

UNIT 4:

Wireless Modulation techniques and Hardware, Characteristics of air interface, Path loss models, wireless coding techniques, , OFDM, UWB radio techniques, Diversity techniques, Typical GSM Hardware. **10 Hours**

UNIT 5:

Introduction to wireless LAN 802.11X technologies, Evolution of Wireless LAN Introduction to 802.15X technologies in PAN Application and architecture Bluetooth Introduction to Broadband wireless MAN, 802.16X technologies. **10 Hours**

TEXT BOOKS:

1. **Mullet**: *"Wireless Telecom Systems and networks"*, Thomson Learning 2006**:**
2. **Lee W.C.Y**, *"Mobile Cellular Telecommunication"*, MGH, 2002.
3. **D P Agrawal**: *"Wireless communication"*, 2nd Edition Thomson learning 2007
4. **David Tse, Pramod Viswanath**, *"Fundamentals of Wireless Communication*", Cambridge 2005

E- Resources:

https://en.wikipedia.org/wiki/Mobile_technology

https://electronicsforu.com › Tech Trends › Technology Focus

https://www.elprocus.com/types-of-wireless-communication-applications/

EC 620: Computer Networks

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 620	Computer Networks	4	0	0	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the concepts of devices related to network architecture, their topologies, and configurations
2. Demonstrate the working knowledge of protocols and their design issues.
3. Identify and analyze the IP address assignment and standards associated with each network.
4. Analyze and design the routing strategies.
5. Analyze the features and operations of end to end delivery mechanisms and their functionalities
6. Demonstrate the skill sets related to the usage of EDA tool for analysis and simulation.

UNIT 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. **12 Hours**

UNIT 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.

10 Hours

UNIT 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: Introduction,

Network Layer services: 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 Hours**

UNIT 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). **12 Hours**

UNIT 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, Flow control, Error control, TCP congestion control. **08 Hours**

Self-learning Component: Electronic Mail (SMTP), 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 A Forouzan:** "*Data Communication and Networking"*, 5th Edition, McGraw-Hill, 2017 (EBook available on web).
2. **Behrouz AForouzan:**"*TCP/IP Protocol suite*", 4th Edition, Tata McGraw-Hill Education, 2010.
3. **James F. Kurose, Keith W. Ross**: "*Computer networking- A Top-Down Approach*", Pearson education, 6th Edition, 2013 (EBook available on web).
4. **Wayne Tomasi**: "*Introduction to Data Communication and Networking*", 1st Edition, Pearson education 2007.

E-Resource:

1. **Video Lectures**: https://nptel.ac.in/courses/106105081/

EC 630: CMOS VLSI Circuits

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 630	CMOS VLSI Circuits	3	0	1	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the VLSI Design flow and the CMOS Process technology.
2. Explain the working of MOSFT and CMOS circuits.
3. Develop and exemplify the combinational and sequential circuits for circuit characterization and power estimation
4. Design, Demonstrate and validate the analog and digital CMOS circuits using Cadence tool.

UNIT 1:

Introduction: A Brief History, MOS Transistors, CMOS Logic, CMOS fabrication and Layout, VLSI Design Flow, Fabrication, Packaging, and testing **08 Hours**

UNIT 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 **08 Hours**

UNIT 3:

Circuit Characterization and Performance Estimation**:** Introduction, Delay Estimation, Logical effort and transistor sizing, Power Dissipation, Interconnect, Design Margin, and Reliability. **08 Hours**

UNIT 4:

Combinational and Sequential circuit design: SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, D-Latch and Edge-Triggered Flip-Flop **08 Hours**

UNIT 5:

Dynamic Logic Circuits - Voltage Bootstrapping Synchronous Dynamic Circuit Techniques High-Performance Dynamic CMOS Circuits and Semiconductor Memories: ROM, SRAM, DRAM circuits. **08 Hours**

Self-Learning Component:

Recent trends and current publications: Nalwa"Handbook of Advanced electronics and Photonic Materials and Devices", Volume 1-10, Academic Pres, IEEE transactions on electronic devices.

Text Books:

1. **Neil H.E. Weste, David Harris, AyanBannerjee:***CMOS VLSI DESIGN: A Circuits and Systems Perspective,"* 3rd Edition, Published by Pearson Education, 2005.
2. **Douglas. A. Pucknell, Kamran Eshragian:**"*Basic VLSI Design,"* 3rd Edition, Eastern Economy Edition, 1994.
3. **R. Jacob, W. Li, David .E. Boyce:**"*CMOS Circuit Design, Layout, and Simulation,"* Prentice Hall India, 1998.
4. **Sung-Mo Kang, Yusuf Leblebici:** "*CMOS DIGITAL INTEGRATED CIRCUITS Analysis and Design,"* 2nd Edition, McGraw Hill, 2003.

E-Resource

1. **https://youtu.be/Gv5fESGW2Ms?list=PLNhFkFk6qEgLxC8XgE38cYNgI1wldYxXZ**
2. **https://youtu.be/lRpt1fCHd8Y?list=PLCmoXVuSEVHlEJi3SwdyJ4EICffuyqpjk**
3. **https://youtu.be/o9vEnzLL-lY?list=PLojsqdbIzJGQtub91c4fF-TcCdzVYAInM**

EC630L: CMOS VLSI Circuits Lab

List of Experiments. (The experiments are conducted using Cadence tool).

PART – A (Digital Experiments)

1. Draw the CMOS schematic and Layout of the inverter circuit, simulate both schematic and layout to determine propagation delay, rise time fall time and Q-point and comment on the results.
2. Draw the CMOS schematic of the 2 input NAND and NOR gate, also draw the layout of the same, and simulate for transient result.
3. Draw the CMOS schematic of the Half Adder circuit and verify it with truth table, and also draw the layout of the same, and simulate for transient result.
4. Draw the CMOS circuit of the 2:1 Multiplexer circuit and verify it with truth table, and also draw the layout of the same, and simulate for transient result.

PART – B (Analog Experiments)

1. Design the Common source amplifier schematic for a gain of 30dB and also draw the layout of the same, simulate the layout for ac analysis and comment on results.
2. Design the Common Drain amplifier schematic and also draw the layout of the same, simulate the layout for ac analysis and comment on results.
3. Design the Common Gate amplifier schematic (Current Gain of 30dB) and also draw the layout of the same, simulate the layout for ac analysis and comment on results.
4. Design the Differential amplifier schematic for a gain of 50dB.

EC 640: Optical Fiber Communication

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 640	Optical Fiber Communication	4	0	0	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Demonstrate the importance of the optical technology in communication, light propagation and fiber structures.
2. Explain and analyze the principles of signal, degradation in fiber, source and detector in optical communication with necessary modeling and analysis.
3. Analyze the design concepts of optical receivers and passive optical components
4. Illustrate system design issues with the help of case studies and design problem related to optical link.
5. Demonstrate awareness about emerging trends in the field of optical communication and networking.
6. Communicate orally and in writing based on literature survey related to latest developments in the OFC and use ICT tool in learning.

UNIT 1:

OFC Principles: Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, Fiber numerical aperture, cylindrical fiber , modal concepts, single mode fiber, cutoff wave length, and mode field diameter. Design optimization of single mode fibers. Optical Fibers: fiber materials, photonic crystal, fiber optic cables, specialty fibers. . **10 Hours**

UNIT 2:

Various losses in fibers: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra modal dispersion, Inter modal dispersion.

Sources and Detectors: Introduction, LED‘s, LASER diodes, Photo detectors, Photo detector noise, Response time, double hetero junction structure, Photo diodes, comparison of photo detectors.

10 Hours

UNIT 3:

Fiber connectors and couplers: Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.

Optical receiver: Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver operation. **10 Hours**

UNIT 4:

Analog and digital links: Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links, microwave photonics. Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, and transmission distance for single mode fibers, Power penalties. **10 Hours**

UNIT 5:

WDM concepts: WDM concepts, overview of WDM operational principles, WDM standards, Mach Zender Interferometer, multiplexer, isolators and circulators, direct thin film filters, active optical components, technology, variable optical attenuators, tunable optical filters, dynamic gain equalizers, optical add/drop multiplexers, tunable light sources. Optical Networks, SONET, SDH, ADM Recent Developments. **10 Hours**

Self-Learning Component: Ray Tracing, Fiber Slicing and Fiber fabrication, optical amplifiers: EDFA and SOA, ASE, system impact, chirping in single-mode fibers, Intensity modulation and Advance topics in fibers.

Text Books:

1. **Gerd Keiser** – "*Optical Fiber Communication*", 5th Edition, MGH, 2013.
2. **John M. Senior** – "*Optical Fiber Communications*", 3rd Edition, Pearson Education, 6th Impression, 2013.
3. **Joseph C Palais** – "*Fiber optic communication"*, 5th Edition, Pearson Education, 11th Impression, 2013.

E-Resource:

1. http://nptel.ac.in/courses/117101054.
2. http://nptel.ac.in/courses/115107095

EC 651: Data Structures and Algorithms

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 651	Data Structures and Algorithms	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Understand programming skills through Object Oriented Programming and evaluate algorithms in terms of time, space complexity and asymptotic analysis.
2. Identify and apply appropriate data structures and algorithms, understand the ADT and use it for a specific problem.
4. Implement and evaluate the data structures using trees for sorting, searching, and traversals for skill enhancement in problem solving.
5. Develop applications using data structures and algorithms.
6. 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 1:

Basic Concepts of Object Oriented Programming: Declaration of Variables, Dynamic Initialization of Variables, Reference Variables, Operators in C++, Functions in C++, Classes and Objects, Constructors and Destructors, Virtual Functions.

Complexity Analysis: Time and Space complexity of algorithms, asymptotic analysis and notations, importance of efficient algorithms, program performance measurement, data structures and algorithms. **08 Hours**

UNIT 2:

Arrays, Matrices and Linked Lists: Abstract data type, sequential and linked representations, comparison of insertion, deletion and search operations for sequential and linked lists, doubly linked lists, circular lists, skip lists. **08 Hours**

UNIT 3:

Stacks and Queues: Abstract data types, stacks, linear queues, circular queues, skip list, representative applications such as parenthesis matching, towers of Hanoi, finding path in a maze.

Hashing: Search efficiency in lists and skip lists, hashing as a search structure, hash table.

08 Hours

UNIT 4:

Trees: Binary trees and their properties, terminology, sequential and linked implementations, tree traversal methods and algorithms, heaps as priority queues, heaps implementation.

Search Trees: Binary search trees, search efficiency, insertion and deletion operations, AVL trees, searching, insertion and deletions in AVL trees

08 Hours

UNIT 5:

Graphs: Definition, terminology, directed and undirected graphs, properties, connectivity in graphs, applications, graph traversal – breadth first and depth first.

Algorithm Design Techniques: Dijkstra's Algorithm, Greedy algorithm (Minimum Spanning Tree), Divide and Conquer (Merge Sort), Dynamic Programming (Shortest Path Problem), backtracking.

08 Hours

Self-Learning Component:

Linked lists through simulated pointers, Wire routing in a circuit, uses of hash tables in text compression, leftist trees, tournament trees, use of winner trees in merge sort as an external sorting algorithm, bin packing, red-black trees, and comparison of different trees with AVL trees.

Text Books:

1. **SartaSahni, S**, *"Data Structures, Algorithms, and Applications in C++"*, WCB/McGraw-Hill. Edition 2001
2. **E. Balaguruswamy**, *"Object Oriented Programming with C++"*, Sixth Edition, McGraw Hill Education, 2014.
3. **Michael T. Goodrich,** *"Data Structures and Algorithm Analysis in C++"*, Third Edition, Pearson Education, 2009.
4. **Thomas H Cormen et.al.** *"Introduction to Algorithms"*, Second Edition, MIT Press, 2001.
5. **Drozdek, A,** " *Data Structures and Algorithms i n C ++"*, Vikas Publishing House, Edition 2002

E-Resource

1. www.nptelvideos.in/2012/11/data-structures-and-algorithms.html
2. https://www.geeksforgeeks.org/list-cpp-stl/
3. http://www.nptelvideos.com/computer_science/datastructures_algorithms.php

EC 652: JAVA Programming

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 652	JAVA Programming	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the behavior of programs involving the fundamental concepts.
2. Analyze and develop programs on object oriented concepts.
3. Apply the knowledge of exceptions and collections in java programming
4. Design the Java applications using threads and networking.
5. Demonstrate the Java programming skills in the analysis and simulation using various IDE tools.

UNIT 1:

An Introduction to Java, The Java Programming Environment, Fundamental Programming Structures in Java-Overview of Java, Datatypes, operators, String handling, Wrapper classes, Control statements. **08 Hours**

UNIT 2:

Objects and Classes, Inheritance, Inner Classes, Packages and Interfaces, Streams. **10 Hours**

UNIT 3:

Exception Handling -Exception-Handling Fundamentals, Exception Types, Using try and catch, Java's Built-in Exceptions, User Defined exceptions.

Multithreading – Java Thread model, Creating a Threads, Creating Multiple Threads, Thread Priorities, Thread Synchronization, Inter-thread Communication, Thread life cycle. **12 Hours**

UNIT 4:

Collections- Collections Overview ,The Collection Interfaces, The Collection Classes, Accessing a Collection via an Iterator,Sets, Lists, Maps,Vector Class. **05 Hours**

UNIT 5:

JDBC- JDBC Driver Types; JDBC Packages; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; ResultSets **05 Hours**

Self learing Components: RMI: Remote Method Invocation concept; Server side, Client side, Servlets programming, Networking

Text Books:

1. **Cay S. Horstmann**, "*Core Java Volume I—Fundamentals"*, 9th Edition, Core Series, November 2012
2. ***Core Java, Volume II--Advanced Features (9th Edition) (Core Series*)** by, Prentice Hall March, 2013.
3. **Herbert Schildt**, "*Java: The Complete Reference"***,** Mcgraw-Hill Osborne Media, 10th edition, 2014

E - Resource:

1. http://nptel.ac.in/courses/106106147/3
2. http://nptel.ac.in/courses/106106147/3
3. https://onlinecourses.nptel.ac.in/noc19_cs07/preview
4. https://nptel.ac.in/courses/106105084/28
5. https://fr.coursera.org/lecture/distributed-programming-in-java/2-1-introduction-to-sockets-XiZXU

EC 653: Python Programming

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 653	Python Programming	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1 Explain the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python
3. Express different Decision Making statements and Functions
4. Interpret Object oriented programming in Python
5. Understand and summarize different File handling operations
6. Explain how to design GUI Applications in Python and evaluate different database operations
7. Design and develop Client Server network applications using Python.

UNIT 1:

Fundamentals of Python, Introduction to Python, Running Python Programs, Writing Python Code, Working with Data, Data Types and Variables, Using Numeric Variables, Using String Variables.

08 Hours

UNIT 2:

Input and Output, Printing with Parameters, Getting Input from a User, String Formatting, Making Decisions, Logical Expressions, The "if" Statement, Logical Operators, More Complex Expressions.

08 Hours

UNIT 3:

Finding and Fixing Problems, Types of Errors, Troubleshooting Tools, Using the Python Debugger, Lists and Loops, Lists and Tuples, List Functions, "For" Loops, "While" Loops. **08 Hours**

UNIT 4:

Numeric and Date Functions, Dates and Times, Advanced Data and Time Management, Random Numbers, The Math Library, Working with Strings, Character Data, String Functions, Input Validation with "try / except". **08 Hours**

UNIT 5:

Functions, Writing and Calling Functions, Function Inputs and Outputs, Local and Global Scope, Python Classes, Thinking about Objects, Class Variables and Methods, Managing Class Files.

08 Hours

Self learing Components: Class Instances, Creating Objects with Instance Data, Instance Methods, Managing Objects, Creative Project (Scale as desired to meet available time), Project Life-cycles and teams.

Text Books:

1. **Richard L. Halterman, "***Fundamentals of Python Programming"*, Southern Adventist University July 9, 2019.

E – Resource:

1. The official Python Tutorial. http://docs.python.org/tut/
2. How to think like a computer scientist (interactive) http://interactivepython.org/runestone/static/thinkcspy/index.html
3. How to think like a computer scientist http://openbookproject.net/thinkcs/python/english3e/
4. Code Academy Python http://www.codecademy.com/tracks/python
5. A useful hands-on book: http://anh.cs.luc.edu/python/hands-on/3.1/Hands-onPythonTutorial.pdf

EC 654: Information Theory and Coding

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 654	Information Theory and Coding	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the entropy, mutual information and channel capacity for all types of channels.
2. Analyze and measure the information per symbol emitted from a source.
3. Evaluate the information capacity of discrete memory less channels and determine possible code rates to achievable on such channels.
4. Distinguish between different types error correcting codes based on probability of error and bit Energy to noise ratio.
5. Apply convolution codes for performance analysis and cyclic codes for error detection and correction.

UNIT 1

Information Theory: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources. **08 hours**

UNIT 2

Source Coding: Source coding theorem, Kraft McMillan Inequality property – KMI. Encoding of the Source Output, Shannon's Encoding Algorithm. Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding, Arithmetic Coding. **08 hours**

UNIT 3

Information Channels: Communication Channels. Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity. Channel Capacity of: Binary Symmetric Channel, Binary Erasure Channel, Muroga's Theorem, Continuous Channels. **08 Hours**

UNIT 4

Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting hamming Codes. Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding using an (n-k) BitShift register, Syndrome Calculation, Error Detection and Correction **08 Hours**

UNIT 5

Cyclic Codes: Golay Codes, BCH Codes. Convolution Codes: Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram. **08 Hours**

Self Learning Component: Prefix Codes, Lempel – Ziv Algorithm, Table lookup Decoding using Standard Array and Viterbi Algorithm, Paper/Journals from advanced topics.

Text Books:

1. **Muralidhar Kulkarni, K.S. Shivapraka:** "*Information Theory and Coding*", 1st Edition, Wiley India Pvt. Ltd, 2015.
2. **K. Sam Shanmugam: "***Digital and analog communication systems"*, John Wiley India Pvt. Ltd, 1996.
3. **Simon Haykin**: "*Digital communication*", John Wiley India Pvt. Ltd, 2008.

E Resource:

1. https://www.kopykitab.com/ebooks/2013/09/1871/sample/sample.pdf
2. https://nptel.ac.in/courses/117101053/
3. https://nptel.ac.in/courses/108102117/

EC 655: Multimedia-Communication

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 655	Multimedia-Communication	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain multimedia information representations, multimedia networks types, and applications.
2. Analyze and apply the text, image, audio and video compression techniques.
3. Analyze the protocols which help in multimedia communication across networks.
4. Integrate the various components of media.
5. Explain the working of the transport protocols.
6. Work effectively as a member or a leader in teams to implement assigned tasks related to advanced topics.

UNIT 1:

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology. **08 Hours**

UNIT 2:

Information Representation: Introduction, Digitization principles, Text, Images, Audio and Video. **08 Hours**

UNIT 3:

Text and image compression: Introduction, Compression principles, text compression, image Compression.

Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. **08 Hours**

UNIT 4:

Audio and video compression: Introduction, Audio compression, video compression, video compression principles, video compression. **08 Hours**

UNIT 5:

Transport Protocol Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks.

08 Hours

Text Books:

1. **Fred Halsall** ,"*Multimedia Communications: Applications, Networks, Protocols and Standards*", Pearson Education, Asia, Second Indian reprint 2002.
2. **Nalin K. Sharda** :"*Multimedia Information Networking*", PHI, 2003.
3. **Ralf Steinmetz, KlaraNarstedt**: "*Multimedia Fundamentals: Vol 1 - Media Coding and Content Processing*", Pearson Education, 2004
4. **Prabhat K. Andleigh, KiranThakrar**: "*Multimedia Systems Design*", PHI, 2004.

E-Resource:

1. E-book: https://www.elsevier.com/books/multimedia-communications/gibson/978-0-12-282160-8
2. Video lecture: https://freevideolectures.com/course/2276/computer-networks/36/nptel.

EC 661: Robotics and Computer Vision

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 661	Robotics and Computer Vision	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Represent mathematically, the position and orientation information of the object in an environment.
2. Analyze the techniques to estimate the location of robot and navigate.
3. Analyze and implement the Kinematics concepts required to manipulate and control the links and joints.
4. Analyze suitable image processing algorithms for robot navigation.
5. Integrate image processing and Robotic control techniques to navigate the robots in a given environment.
6. Implement robotic vision and control algorithms using modern tools by working in a group, document and present the results in professional manner.

UNIT 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

08 Hours

UNIT 2:

Mobile Robot Vehicles: Mobility, Car-like vehicles, moving to a point, line & pose, 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 & mapping Monte-Carlo approach. **08 Hours**

UNIT 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

08 Hours

UNIT 4:

Computer Vision Fundamentals: Light & color Spectral representation of light Color, color spaces, color gamut, color consistency, White balance Gamma correction, Image formation Perspective imaging, calibration Fisheye, catadioptric& unified imaging.

Image processing: Acquiring images from files, cameras and the web, Image histograms, Monadic operation, Diadic operations, Spatial operations: convolution, template matching, rank filtering Morphology: image cleanup, skeletonization, hit-or-miss transform Shape changing: cropping, resizing, warping, pyramids.

08 Hours

UNIT 5:

Image feature extraction: Region features: segmentation, thresholding, MSER, graph-based Line features: Hough transform Point features: Harris, SURF

Using multiple images: Fundamental & essential matrix, estimation & RANSAC Homographies Dense stereo, rectification ICP and plane fitting, Examples: perspective undistortion, mosaicing, image retrieval

Visual Servoing: Position-based visual servoing (PBVS), Image feature motion due to camera motion, Controlling feature motion — image-based visual servoing (IBVS), estimating depth.

08 Hours

Self-Learning Components: Study the recent Journal paper: 3-D Mapping with RGB-D Camera by Felix Endres et.al., IEEE Transaction on Robotics, Vol 30 (1), 2014.

TEXT BOOKS:

1. **Peter Corke,** *Robotics, Vision and Control: Fundamental Algorithms In MATLAB,* Second Edition, Springer, 2017
2. **Mark Spong, M. Vidyasagar**, *Robot Dynamics and Control*, Wiley Student Edition 2004.
3. **R. K. Mittal** and **I. J. Nagarath**: *Robotics and Control,* 6th Reprint, Tata Mcgraw-Hill Education, Delhi 2007.

E-Resource:

1. **Video Lecture:** https://robotacademy.net.au/masterclass/introduction-to-robotics

EC 662: Digital Image Processing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 662	Digital Image Processing	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Demonstrate the knowledge on Digital image fundamentals and Image enhancement techniques in spatial and frequency domain.
2. Apply basic morphological and Segmentation algorithms for digital image processing.
3. Understand the various color models analyze and apply them for color image processing
4. Evaluate the various image compression techniques and its applications.
5. Demonstrate critical thinking by exploring recent trends in image processing and implementing various image processing algorithms.

UNIT 1:

Digital Image Fundamentals: Elements of visual perception, Image sensing and acquisition, Image sampling and quantization, 2D sampling theorem, spatial and intensity resolution, Image interpolation and resampling, Basic relationships between pixels.

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.

08 Hours

UNIT 2:

Image Enhancement in Frequency Domain: The2D Discrete Fourier Transform and its inverse, Some properties of the 2D DFT, FFT and IFFT in 2D, Frequency domain filtering fundamentals, Correspondence between filtering in spatial and frequency domain, smoothing and sharpening using Butterworth and Guassian Lowpass and High pass filters, The Laplacian in the frequency domain, Unsharp masking, High boost filtering, High frequency emphasis filtering, Homomorphic filtering.

08 Hours

UNIT 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. **08 Hours**

UNIT 4:

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

Image segmentation: Point, line and edge detection (Robert, Canny and Prewitt techniques), Thresholding, Basic global thresholding, optimum global thresholding using Otsu's method, Region based segmentation. **08 Hours**

UNIT 5

Image Compression: Fundamentals, Some basic compression methods- Huffman, Arithmetic and LZW coding techniques, Fractal image Compression, Digital image watermarking. **08 Hours**

Self-Learning Components: Recent trends and Case studies: Pattern recognition problems from recent journal publications.

Text Books:

1. **Rafael C. Gonzalez & Richard E. Woods:** "*Digital Image Processing***"**, 3rd edition, Pearson Prentice Hall, 2014
2. **Anil K. Jain**, "*Fundamentals of Digital Image Processing***"**, Prentice Hall India, 2016.
3. **John C Russ**, "*The Image Processing Handbook*", 5th edition, CRC Press, 2006.
4. **Maria Petrou and Costas Petrou**, "*Image Processing: The Fundamentals***"**, 2nd Edition, Wiley Blackwell, 2010.

E-Resource:

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

EC 663: Micro-Electro-Mechanical Systems (MEMS)

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 663	Micro-Electro-Mechanical Systems (MEMS)	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the fundamentals of MEMS and Microsystems.
2. Apply scaling laws in miniaturization of MEMS.
3. Analyze the design considerations of Microsystems.
4. CO4: Interpret various case studies on MEMS devices.
5. Demonstrate the skills sets using software tools for MEMS device fabrication. Modern tool, Independent study, Communication Skill, Life-long learning.

UNIT 1:

Overview and working principles of MEMS and Microsystems: MEMS and Microsystems, Typical MEMS and Micro system products — features of MEMS, The multidisciplinary nature of Microsystems design and manufacture. Introduction, Microsensors, Microactuation, MEMS and Microactuators, Microaccelerometers, Industrial applications of Microsystems. **08 Hours**

UNIT 2:

Engineering science for Microsystems Design and Fabrication: Atomic structure of matter, Ions and Ionization, Molecular theory of matter, Doping of semiconductors, Diffusion process, Plasma physics, Electrochemistry. Quantum physics. **08 Hours**

UNIT 3:

Scaling laws in Miniaturization: Introduction to scaling, scaling in geometry, scaling in rigid body dynamics, scaling electrostatic forces, electromagnetic forces and electricity. Scaling in fluid mechanics and heat transfer. **08 Hours**

UNIT 4:

Materials for MEMS and Microsystems: Introduction, Substrate and wafers, Silicon as substrate materials, Silicon compounds, silicon piezo resistors, GaAs, Quartz, Piezoelectric crystals and Polymers.Packaging materials **08 Hours**

UNIT 5:

Overview of Microsystems Fabrication Process & Micro manufacturing: Introduction, Photolithography, Ion-implantation, diffusion, oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, deposition by epitaxy, etching. Some MEMS fabrication processes: surface micro-machining, bulk micromachining, LIGA process. NEMS devices **08 Hours**

Text books:

1. **Tai Ran Hsu,** *"MEMS and Micro Systems: Design and Manufacture"*, Tata McGraw Hill- 1st Edition, 2002.
2. **Chang Liu,** *'Foundations of MEMS'*, 2nd Edition, Pearson Education Inc., 2006.
3. **Danny Banks,** *"Micro engineering, MEMS and interfacing, A Practical Guide"*, Monisys Ltd. Birmingham, England, Taylor and fancies group, Copyright CRC Press, 2006.
4. **Nadim Maluf,** *"An Introduction to Micro Electro Mechanical System Design"*, Artech House, 2000.

E-resource

1. https://www.youtube.com/watch?v=j9y0gfN9WMg
2. https://www.engr.uvic.ca/~mech466/MECH466-Lecture-1.pdf

EC 664: Advanced Digital Signal Processing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 664	Advanced Digital Signal Processing (ADSP)	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Design basic IIR and FIR filters.
2. Analyze the model random signals as output of digital filters.
3. Understand, analyze and implement adaptive filters and algorithms.
4. Estimate power spectrum of a random signal from a realization.
5. Explain and use concepts of multi-rate DSP systems

UNIT 1:

DSP overview: Discrete time signals and systems, structures of DT systems, convolution, deconvolution, correlation, Z transform, Fourier transforms, DFT, radix-2 FFT algorithms, FIR and IIR filters. **08 Hours**

UNIT 2:

Parametric Signal modeling, Pade Approximation, Prony's method, Linear Prediction, Properties of LP filters, Lattice filters, Wiener filters, AR and ARMA models, Levinson-Durbin Algorithm.

08 Hours

UNIT 3:

Introduction to Adaptive filters, applications of adaptive filters, steepest descent algorithm, LMS, Normalized LMS and RLS algorithms, Convergence issues. **08 Hours**

UNIT 4:

Introduction to Power Spectrum Estimation, Periodogram, Non- Parametric methods: Bartlett's method, Welch's method, Blackman-Tukey, Parametric Methods: AR, MA, ARMA spectrum estimation. **08 Hours**

UNIT 5:

Introduction to Multirate DSP, Decimation, Interpolation, Sampling rate conversion, Applications of Multirate signal processing, Digital filter Banks, Introduction to STFT and Wavelet transforms, Applications. **08 Hours**

Text Books:

1. **John G Proakis and Dimitris G Manolakis,** *Digital Signal Processing*, Fourth Edition, Pearson Education, 2007.
2. **Monson H. Hayes, "***Statistical Digital Signal Processing and Modelling*", John Wiley & Sons, 2008.
3. **P. P.Vaidyanathan, "***Multirate Systems and Filter Banks"*, Pearson Education, 2006
4. **Shalini Apte, "***Advanced Digital Signal Processing*", Wiley India Ltd, 2013.

E Resource:

1. https://www.youtube.com/watch?v=4ufeTZ6fSNY&list=PLbMVogVj5nJRY7X-tMNDHPGdmfZyfHC7J
2. https://www.youtube.com/watch?v=sVmWBPSPxNY&list=PLxCOMT0J3XjV2joKgRTX6sGSu22IWRs9q
3. https://www.youtube.com/watch?v=uwr3nG990v8&list=PL4K9r9dYCOopWcmLC0XZqA1Wo-CC8p2ID

EC 665: Machine Learning

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 665	Machine Learning	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Demonstrate the machine learning concepts, its perspectives and issues.
2. Demonstrate Knowledge on various Decision tree methods.
3. Analyse the role of artificial neural networks in the context of machine learning.
4. Demonstrate the knowledge on probabilistic learning methods.
5. Apply the theoretical characterisation of the difficulty of machine learning problems and Capabilities of machine learning algorithms.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task and effectively present in written and oral form.

UNIT 1:

Basic Principles: Introduction, The concept learning task. General-to-specific ordering of hypotheses Version spaces Inductive bias Experimental Evaluation: Over-fitting, Cross-Validation. **08 Hours**

UNIT 2

Supervised Learning: Decision Tree Learning: Decision tree Representation, Appropriate problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive Bias indecision Tree Learning, Issues in decision Tree Learning. **08 Hours**

UNIT 3

Artificial Neural Networks: Neural Network Representation, Perceptrons, Multilayer networks and the back-propagation Algorithm. Remarks on the Back propagation Algorithm, An Illustrative Example: Face Recognition, Advanced Topics in Artificial Neural Networks **08 Hours**

UNIT 4

Probabilistic Learning: Bayesian Learning: Bayes Theorem, Bayes Theorem and Concept Learning, Maximum Likelihood Hypothesis for predicting Probabilities, Gibbs Algorithm, Bayesian Belif Networks, The EM Algorithm **08 Hours**

UNIT 5

Computational Learning Theory: probably learning an Approximately Correct Hypothesis, Sample Complexity for Finite Hypothesis Spaces, The Vapnik-Chervonenkis Dimension, Instance- Based Learning: K-Nearest Neighbour Learning **08 Hours**

Text Books:

1. **Tom Mitchell.** *"Machine Learning"* McGraw Hill Education(India) Edition, 2013.
2. **Christopher M. Bishop.** *"Pattern Recognition and Machine Learning"*. Springer ,2nd Edition,2006.

E Resource:

1. https://www.youtube.com/playlist?list=PLLssT5z_DsK-h9vYZkQkYNWcItqhlRJLN
2. https://www.youtube.com/playlist?list=PL9ooVrP1hQOHUfd-g8GUpKI3hHOwM_9Dn
3. https://www.youtube.com/playlist?list=PLEiEAq2VkUULYYgj13YHUWmRePqiu8Ddy

EC 67L: Computer Networks Lab

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 67L	Computer Networks Lab	0	0	1	1	50	50	100

Course outcome: At the end of the course, the student should be able

1 Use the network simulator for learning and practice of networking algorithms.

2 Illustrate the operation of network protocols and algorithms using C programming.

3 Analyze various Routing protocols and addressing schemes by creating various network configurations.

4 Work in a group to complete the task adhering to schedule and communicate effectively in written and oral formats.

PART-A: Simulation experiments using CISCO Packet Tracer/ GNS3 Tool.

1. Study of different types of Network cables and practically implement the cross-wired cable and straight through cable using clamping tool.

2. Using CISCO packet Tracer, perform the following experiments
   a. Configure a basic Network topology.
   b. Ping and Trace.
   c. Investigate Unicast, Broadcast and Multicast Traffic.

3. Using CISCO Packet Tracer, Perform the following experiments
   a. Skills Integration challenge-planning subnets and configuring IP addresses.
   b. Observing the effects of collision in a shared media environment.
   c. Static routing and default routing.

4. Configure a Network topology using Distance Vector Routing protocol (IPv4, Ipv6).

5. Configure a Network topology using Link State Routing protocol (IPv4, Ipv6).

6. Using CISCO Packet Tracer, Perform the followings
   a. Network Address Translation (NAT)
   b. Access Control List (ACLs)

7. Using packet Tracer, perform the following experiments
   a. Basic switching configuration.
   b. Configure VLAN and Inter-VLAN routing for a Network.

PART-B: Implement the following in C/C++/python.

1. Write a program for a HLDC frame to perform the following.
   i) Bit stuffing and destuffing.
   ii) Character stuffing and destuffing.
2. Write a program for distance vector algorithm to find suitable path for transmission.
3. Implement Dijkstra's algorithm to compute the shortest routing path.
4. For the given data, use CRC-CCITT polynomial to obtain CRC code. Verify the program for the cases
   i) Without error
   ii) With error
5. Implementation of Stop and Wait Protocol and Sliding Window Protocol (GBN and SR Protocol).
6. Write a program for minimum spanning tree using kruskal's/Prim's algorithm.
7. Write a socket programing for client – server Model.

References

Todd Lammle: "*CCNA Routing and switching complete study Guide*" 2nd Edition, SYBEX, 2013.

VII Semester

EC 710: Entrepreneurship and Management

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 710	Entrepreneurship and Management	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1 Explain entrepreneurship, management and innovation with an emphasis on their evolution.
2 Identify and describe various institutional support for starting new business, assessment of demand and supply in potential areas of growth, opportunity identification and feasibility analysis.
3 Analyze the importance of technology management with respect to organizational finance, ethics, team work and project planning.
4 Investigate techno-economic feasibility of a project, prepare a report, develop a business plan and critically evaluate.
5 Identify the outcomes of innovation with regard to IPR and patents in technology oriented business.
6 Assess various successful entrepreneurial profiles, analyze the industrial manufacturing ecosystem and give a presentation on start-up companies by working in teams and discuss case examples.

UNIT 1:

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. **08 Hours**

UNIT 2:

Role of financial institutions: Role of financial institutions in entrepreneurship development like 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/organizations. Market Survey and Opportunity Identification (Business Planning):How to start an industry, procedures for registration of industry,

assessment of demand and supply, in potential areas of growth, understanding business opportunity, considerations in product selection, data collection for setting up new ventures.

08 Hours

UNIT 3:

Engineering Management: Introduction to Engineering Management: Motivation (discussion on historic engineering marvels), Engineering and Management, historical development of engineering management, systems approach to management, scientific approach to management , case examples **08 Hours**

UNIT 4:

Technology management: Functions of technology management: planning and forecasting, decision making, organizing, motivating and leading technical people, controlling. Managing projects: Project planning and acquisition, project organization, leadership and control. Case Studies. **08 Hours**

UNIT 5:

Project Report Preparation: Preliminary report, Techno-economic feasibility report, Project viability. Case studies. **08 Hours**

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. **Poornima Charanthimath,** "Entrepreneurship Development and small Business Enterprises", Pearson Education, 2nd Edition 2009.
4. **Barringer, Duane,** "*Entrepreneurship Successfully Launching New Ventures*", 4th edition, Prentice Hall, 2009.

E Resource:

1. https://www.youtube.com/watch?v=tfSanirO3lk&list=PL-ZxmUJb8PI0EaoLAH7qMzGT02hdl7TFg
2. https://www.youtube.com/watch?v=zy-3tfBAXFE&list=PL_a1TI5CC9RHDpR-aABl0vbTxnG2WV5Do
3. https://www.youtube.com/watch?v=ATLUouxwykM&list=PLibYlioyRBiDQQMOqtAl5Yyfi6u052krb

EC 720: Power Electronics

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 720	Power Electronics	3	0	1	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the various power devices and circuits.
2. Analyze different power electronics circuits.
3. Design power circuits to meet the given specifications.
4. Design and demonstrate the working of various power electronic circuits.
5. Demonstrate the skill sets using modern tool for analysis and simulation of power electronics circuits.

UNIT 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.

08 Hours

UNIT 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.

08 Hours

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

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.
3. **Daniel W. Hart:** "*Power Electronics*", 1st Edition, McGraw Hill, 2011.
4. **L. UMANAND:** "*Power Electronics Essentials and applications*", 3rd Edition, John Wiley and sons, Inc, 2009.
5. **V.R Moorthi:** "*Power Electronic Devices, Circuits & Industrial Applications*", 1st Edition, Oxford University Press, 2005.

E Resource:

1. https://www.youtube.com/playlist?list=PLgwJf8NK-2e5Hnu82T1CYLZ8kbZs4Jx8x
2. https://www.youtube.com/playlist?list=PLA07ACBDE053A8229

EC 720L: Power Electronics Lab

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 720L	Power Electronics Lab	0	0	1	1	50	50	100

List of Experiments

1. Analysis of static and dynamic characteristics of MOSFET and IGBT.
2. Analysis of static and dynamic characteristics of Power Transistor and SCR.
3. Performance analysis of Controlled HWR and FWR using RC triggering/ UJT firing circuit.
4. Performance of Single phase fully controlled and semi controlled converters for R and RL loads for continuous current mode.
5. Performance analysis of AC voltage controller using Triac- Diac combination.
6. Performance analysis of Series and Parallel inverters.
7. Performance analysis of Single phase bridge inverter for R and RL Load and voltage control by single pulse width modulation.
8. Performance analysis of two quadrant choppers.
9. Study and performance analysis of single phase semi controlled converter fed separately excited DC motor for continuous current mode.
10. Study of Generation of firing signals for converters / inverters using digital circuits / microprocessors.

EC 731: Automotive Electronics

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 731	Automotive Electronics	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. **Exhibit** the knowledge of working of Sensors and actuators in Electronic fuel injection, ignition systems and Active / Passive safety systems.
2. **Demonstrate**, a comprehension of the roles and implementations of various bus systems used in automotive networking.
3. **Explain** and **analyze** the main requirements, trends and selection criteria of sensors for automotive applications.
4. **Exemplify** the different measuring principles involved in sensors and evaluate for automotive applications.
5. **Demonstrate** the knowledge of basic principle of actuators and explain the mechanism of hybrid drives.
6. Work efficiently in a group and complete the assigned task by **demonstrating** skills related to documentation and oral communication.

UNIT 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.

SLE: Advanced engine management technologies – Artificial intelligence and Neural computing.

08 Hours

UNIT 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.

SLE: Connected cars, central electrical control. **08 Hours**

UNIT 3

Automotive sensors: Basics and overview, automotive applications, Sensor market, Features of vehicle sensors, Sensor classification, Selection of sensor technologies**.**

SLE: Advanced instrumentation technology – holography, telemetry, telematics. **08 Hours**

UNIT 4

Sensor measuring principles: Sensors for the measurement ofposition, 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.

SLE: LVDT, Dynamic vehicle position sensor, optical sensor, light sensor. **08 Hours**

UNIT 5

Actuators: Electromechanical & fluid mechanical actuators, Electrical machines

Hybrid drives: Drive concepts, operating strategies for electric hybrid vehicles, Recuperative brake system, Electrical energy accumulators.

SLE: Wireless EV charging, advanced electric vehicle technology. **08 Hours**

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

E- Resource:

1. https://www.youtube.com/playlist?list=PLCBA3EF828DFE7B0E
2. https://www.youtube.com/watch?v=STDlCdZnIsw&list=PLE06CAA834360BB39
3. https://www.youtube.com/watch?v=OWbXjvtG7Dc&list=PL5__U-kYrFIg5OEfvtnw0Cp1u8pqe1DMN

EC 732: Nano science and Technology

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 732	Nano science and Technology	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Acquire the knowledge on fundamental concepts of nanostructures and synthetic aspects.
2. Comprehend spectroscopic techniques.
3. Acquire the knowledge on nanostructures and their characterization.
4. Identify the methods of preparing self-assembling nano structured molecular materials.
5. Acquire the knowledge on concept of bio nanotechnology towards sensor applications.
6. Work effectively as a member/leader in teams to complete the assigned tasks.

UNIT 1

Introduction: Overview of nano science and engineering. Classification of Nanostructures, Electronic properties of atoms and solids, Fabrication methods, Top down processes, Bottom up processes methods for templating the growth of nanomaterials. **08 Hours**

UNIT 2

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk, surface, spectroscopy techniques: photon, radiofrequency, electron, surface analysis. **08 Hours**

UNIT 3

Inorganic semiconductor nanostructures: overview of semiconductor physics, Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super lattices, band offsets, electronic density of states. Semiconductor nano crystals, colloidal quantum dots, self-assembly techniques. Optical, electrical and structural characterization of semiconductor nanostructures. **08 Hours**

UNIT 4

Properties of nanoparticles: metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis. Carbon nanostructures and its applications. Self-assembling nano

structured molecular materials and devices, methods to prepare and pattern nanoparticles, templated nanostructures. Nanomagnetism in technology and challenges. **08 Hours**

UNIT 5

Introduction to Bionanotechnology: New tools in biological systems, Biomimetic nanotechnology: DNA as building block, Molecular electronics and its applications, Applications of FET label free electrical DNA biosensor arrays, impact of nanotechnology on the environment. **08 Hours**

Self-Learning Components: Bonding of atoms and electronic conduction, Reflection High Energy Electron Diffraction (RHEED), Position-sensitive Atom Probe (POSAP) Spectroscopy, Light emitting semiconductor quantum dots, nano cuboids, graphene, carbon quantum dots, single crystalline silicon, thin film transistor arrays.

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 Pte. Ltd., Copyright 2006, Reprint 2011.
3. **MehmatOzsoz,** "*Electrochemical DNA biosensors"*, Pan Stanford publishing Pvt. Ltd. Singapore, 2012.

E-Resources

1. https://nptel.ac.in/courses/104103019/6
2. https://www.youtube.com/watch?v=ebO38bbq0_4
3. https://www.youtube.com/watch?v=urkHytFJmck

EC 733: Satellite Communication

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 733	Satellite Communication	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the basic concepts of orbital mechanics of satellites.
2. Apply the basic concepts to identify the satellites design criteria and to design space link.
3. Summarize different aspects of earth segment and quantifying various parameters.
4. Explain the working of multiple access techniques used for satellite communication.
5. Explore the different application of satellite communication.
6. Demonstrate the skill sets related to software tools in the analysis and simulation, case study and submit a report in satellite communication.

UNIT 1

Satellite Orbits : Introduction, Kepler‟s Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion . **08 Hours**

UNIT 2

Space Segment and Space Link Design: Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite uplink and downlink Analysis and Design, link budget, E/N calculation- performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency considerations- System reliability and design lifetime. **08 Hours**

UNIT 3

Earth Segment: Introduction – Receive – Only home TV systems – Outdoor unit – Indoor unit for analog (FM) TV – Master antenna TV system – Community antenna TV system – Transmit – Receive earth stations – Problems – Equivalent isotropic radiated power – Transmission losses – Free-space transmission – Feeder losses – Antenna misalignment losses – Fixed atmospheric and ionospheric

losses – Link power budget equation – System noise – Antenna noise – Amplifier noise temperature – Amplifiers in cascade – Noise factor – Noise temperature of absorptive networks – Overall system noise temperature – Carrier to- Noise ratio – Uplink – Saturation flux density – Input back off – The earth station – HPA – Downlink – Output back off – Satellite TWTA output – Effects of rain – Uplink rain– Fade margin – Downlink rain – Fade margin – Combined uplink and downlink C/N ratio – Inter modulation noise. **08 Hours**

UNIT 4

Satellite Access: Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, Assignment Methods, Spread Spectrum communication, compression – encryption. **08 Hours**

UNIT 5

Satellite Applications: INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, and Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB) - Worldspace services, Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet. **08 Hours**

Self-Learning Components: Remote Sensing Satellites, Weather Forecasting Satellites, Navigation Satellites.

Text Books:

1. **Dennis Roddy**: *"Satellite Communications"*, 4th Edition, McGraw- Hill International edition, 2006.
2. **Timothy Pratt, Charles Bostian, and Jeremy Allnutt**: *"Satellite Communications"*, 2nd Edition, Wiley India Pvt. Ltd, 2017, ISBN: 978-81-265-0833-4.
3. **Anil K. Maini, Varsha Agrawal**: *"Satellite Communications"*, 2nd Edition Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.
4. **M.Richharia**: *"Satellite Communication Systems-Design Principles"*, 2nd Edition, Macmillan 2003.

E-Resource

1. **https://nptel.ac.in/syllabus/117105131**
2. **https://nptel.ac.in/syllabus/117107036**

EC 734: Quantum Computing and Communication

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 734	Quantum Computing and Communication	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the concepts and challenges of quantum mechanics as applied to communications.
2. Apply the techniques which determine the performance of a quantum network.
3. Analyze how applications actually operate over quantum a communication channel.
4. Design and simulate the behavior of quantum networks.

UNIT 1:

Fundamental Concepts: Global Perspectives, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum Information, Postulates of Quantum Mechanisms. **08 Hours**

UNIT 2:

Quantum Computation: Quantum Circuits – Quantum algorithms, Single Orbit operations, Control Operations, Measurement, Universal Quantum Gates, Simulation of Quantum Systems, and Quantum Fourier transform, Phase estimation, Applications. **08 Hours**

UNIT 3:

Quantum Computers: Guiding Principles, Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer – Optical cavity Quantum electrodynamics, Ion traps, Nuclear Magnetic resonance. **08 Hours**

UNIT 4:

Quantum Information: Quantum noise and Quantum Operations – Classical Noise and Markov Processes, Quantum Operations, Examples of Quantum noise and Quantum Operations – Applications of Quantum operations, Limitations of the Quantum operations formalism, Distance Measures for Quantum information. **08 Hours**

UNIT 5:

Quantum communication: Quantum communication with continuous variables: phase space in quantum optics, continuous-variable entanglement, teleportation and entanglement swapping, entanglement distillation, quantum cryptography. Quantum computation with continuous variables. An ensemble of identical two-level atoms, electromagnetically induced transparency, quantum memories and quantum repeaters, the atomic ensemble of a single qubit, photon-photon interactions via atomic ensembles, **08 Hours**

Self-Learning Components: Quantum Error Correction - Theory of Quantum Error –Correction, Constructing Quantum Codes, Stabilizer codes, Fault – Tolerant Quantum Computation, Entropy and information – Shannon Entropy, Von Neumann, Strong Sub Additivity, Data Compression, Entanglement as a physical resource.

Text Books:

1. **Michael A. Nielsen & Isaac L. Chuang,** *Quantum Computation and Quantum Information* 10th Edition Cambridge University Press - 2010
2. **P. Kok and B. W. Lovett**, *Introduction to Optical Quantum Information Processing*,1st edition, Cambridge university press – 2010.
3. **D. Bouwmeester, A. K. Ekert, and A. Zeilinger**, eds. *The Physics of Quantum Information*, Springer-2013
4. **L. Mandel, and E. Wolf.** *Optical Coherence and Quantum Optics*, 1st edition, Cambridge University Press 1995

E-Resource

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

EC 735: Bio-medical Signal Processing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 735	Bio-medical Signal Processing	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Apply basic knowledge to study origins and characteristics of biomedical signal.
2. Analyze the different sources of noise and artifacts of biological signals.
3. Design model to study various events and waveform complexities of different biological signals.
4. Implement an algorithm as a team-member to design and implement experiments using modern tools.

UNIT 1:

Introduction to Biomedical Signals: Classification of signals, the nature of biomedical signals, the action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis. **08 Hours**

UNIT 2:

Neurological signal processing: The brain waves and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis, Linear prediction theory, The Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, Transient detection and elimination- The case of epileptic patients, overall performance. **08 Hours**

UNIT 3:

Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modeling sleep. **08 Hours**

UNIT 4:

Adaptive Interference/Noise Cancellation: A review of Wiener filtering problem, Principle of an Adaptive filter, The steepest-descent algorithm, the Windrow-Hoff least mean square adaptive

algorithm, Adaptive noise canceller, Cancellation of 60Hz interference in ECG, canceling of maternal ECG in fetal ECG. **08 Hours**

UNIT 5:

Cardio-logical Signal Processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG parameters and their estimation, The use of multi-scale analysis for parameter estimation of ECG waveforms, Arrhythmia analysis monitoring, long term continuous ECG recording. **08 Hours**

Self-Learning Components: ECG Data Reduction Techniques, Direct data compression techniques, Direct ECG data compression techniques, Transformation compression techniques, Data compression techniques comparison.

Text Books:

1. **D C Reddy:** *"Biomedical Signal Processing Principles and Techniques"*, 1st Edition, Tata McGraw Hill publications, 2005.
2. **Rangaraj M. Rangayyan:** "*Biomedical Signal Analysis A case study approach*" , 2nd Edition, John Wiley publications, 2002
3. **Willis J Tompkins:** *"Biomedical Digital Signal Processing"*, Prentice Hall, 2000.
4. **Eugene N. Bruce:** "*Biomedical Signal Processing & Signal Modeling*," Wiley publications, 2001.

E-Resource

1. Ocw.mit.edu › Courses › Health Sciences and Technology MIT Open Course War
2. http://ocw.mit.edu
3. www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images
4. www.crcpress.com › Biomedical Science › Biomedical Imaging.
5. downloads.hindawi.com/journals/special issues/129194.pdf

EC 736: E-Waste Management

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 736	E-Waste Management	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Understand E-waste and its hazardous effects
2. Explain components of e-waste and various strategies on its management
3. To Analyse risk and make its assessment ,recycling and Recovery of metals from E-waste
4. Understand various e- waste management methods, Policies for e-waste management
5. Work in groups to spread e-waste management Knowledge, regulations, guidelines, legal, aspects of management of E wastes among community

UNIT 1:

Introduction to Solid Waste and E waste: Introducing Municipal Solid Waste, overview, Waste Generation Aspects, Waste Collection, Storage and Waste Processing Techniques, problems of hazardous waste, industrial waste , E-waste, E-waste sources**,** Generation, An estimation to e-waste, Pollutants in e-Waste, Effects of e-waste on human health and environment. **08 Hours**

UNIT 2:

E-waste Management strategies: Management of e-waste, Challenges for e-waste management, Inventory management, Production-process modification, Volume reduction, Recovery and reuse, Sustainable product design, Responsibilities of the Government, Responsibility and Role of industries, Responsibilities of the Citizen, Global Issues including Exports to Poor Countries, Environmental and Public Health Issues of Electronic waste management. **08 Hours**

UNIT 3:

Regulations to E-waste management: E-waste policy and regulation, ITU- Technical guidelines, ITU- Present Activities Problems in the implementation of a strategy on ICT-waste, Electronic Waste Management in India, Existing Regulations and guidelines, Life Cycle Analysis and Sustainable Engineering especially from an Electrical and Electronics industry Perspectives, Socio-Economic Life Cycle Analysis (SLCA) of E-Waste Management in Developing countries. **08 Hours**

UNIT4:

Recycling of E-Waste: Exposure pathway of pollutants emitted from Recycling of E-Waste, Quantification of Pollutants in Dust, Air and Water, Risk Assessment (According to USEPA method) of Recycling of E-Waste, Recovery of Valuable Rare-Earth metals from E waste, E-Waste Management Rules of India (2011 and 2016 Rules), E-waste Regulations from around the World (European, North America etc.), WEEE rules, EPR concepts, Compare and Contrast with Indian E-waste rules. **08 Hours**

UNIT 5:

Physiochemical and Biological treatment of E-Waste: Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation, Biological Treatment of Solid and Hazardous Waste, Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation. **08 Hours**

Text Books:

1. **Freeman M. H.** "*Standard Handbook of Hazardous Waste Treatment and Disposal*", McGraw-Hill Company, USA 1989.
2. **Lagrega M.D., Buckingham P.L., and Evans J.C,** "*Hazardous Waste Management*", McGraw Hill International Edition 1994.
3. **Michal D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans**. "*Hazardous Waste Management: Second Edition. Environmental Resources Management*", Waveland Press, Inc. 2010.
4. **Wentz C.A.,** "*Hazardous Waste Management*", McGraw Hill 1989.
5. **M.N.V Prasad, Meththika Vithanage,** "*Electronic Waste Management and Treatment Technology*", Elsiever Inc. – 2019.

E Resource:

1. https://www.youtube.com/watch?v=EJeTOUSmkBE&list=PLQC-_J4xl9DT0LuLJAKspLoc8Xq2IWYzb
2. https://www.youtube.com/watch?v=STcFSthSJWo&list=PL3MO67NH2XxIYo-UFN8csPPnEiYVyR0TO

EC 741: Internet of Things

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 741	Internet of Things	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Able to identify the basic concepts, enabling technologies, possibilities and applications of IOT from a present and a futuristic view point
2. Demonstrate and analyze the requirements and configurations for Connectivity Technologies.
3. Able to explain and analyse the routing protocols suitable for IOT
4. Able to identify and analyze the Embedded Devices for IOT s.
5. Demonstrate comprehensive understanding about applications, case study, test bed scenarios related to IOT , based on group task, seminars etc.,

UNIT 1

Introduction to IoT: The definition and characteristics of the Internet of Things, main assumptions and perspectives.. Platform for IoT devices, Device architectures, physical design, logical design, Enabling technologies, IoT Levels & Deployment Templates, ITU-T IoT Reference Model

08 Hours

UNIT 2:

IOT and M2M : comparison, Devices and gateways, Managing M2M data- Data generation, Data acquisition, Data validation, Data storage, Data processing, Data remanence, Data analysis.

08 Hours

UNIT 3

IoT components, inter-dependencies, SoA, gateways, comparison between IoT & Web, difference protocols, complexity of networks, wireless networks, scalability, protocol classification, MQTT & SMQT(NPTEL Lec6 week 2)Service oriented protocols (COAP).-Communication protocols based on the exchange of messages(MQTT), XMPP, AMQP. **08 Hours**

UNIT 4

Zigbee: Zigbee architecture, routing algorithm, security, IEEE 802.15.4, 6LowPAN, RFID, NFC, Embedded Devices for IoTs, Cloud and FOG computing. **08 Hours**

UNIT 5

Applications and Case Studies: Smart Grid, Home Automation, Smart City, agriculture, health care, IIoT. **08 Hours**

Self-Learning Components: Paper/ Journals on Recent trends in IoT

Text Books:

1. **Rajkumar Buyya**: *"Internet of Things : Principles and Paradigms"*
2. **Raj Kamal**: *"Internet of Things - Architectures and Design principles"*
3. **Olivier Hersent**: *"The Internet of Things"* , Willey student edition, Reprint, 2015
4. **Jan Ho¨ller**: *"From Machine-to-Machine to the Internet of Things"*, Academic Press, 2014
5. **Arshdeep Bahga**: *"Internet of Things"*, Universities press,2015

E Resource:

1. https://nptel.ac.in/courses/106105166/
2. https://freevideolectures.com/blog/guide-to-learn-internet-of-things-iot/

EC 742: Storage Area Network

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 742	Storage Area Network	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Demonstrate a knowledge of fundamentals of storage systems and network technologies.
2. Describe the different types of RAID implementations and their benefits.
3. Analyze the metrics used for designing storage area networks.
4. Demonstrate the knowledge of various concepts and techniques of storage virtualization.
5. Describe the different role in providing disaster recovery and business continuity capabilities.
6. Demonstrate an ability to work individually or in a team to carry out assigned tasks, by leveraging recent open source tools, adhering to standard practices and ethics; Communicate effectively in oral and verbal methods.

UNIT 1:

Introduction: Introduction to Information Storage and Management, Storage System Environment Information Storage, Evolution of Storage Technology and Architecture, Data Center Infrastructure, Key Challenges in Managing Information, Information Lifecycle Components of Storage System Environment, Disk Drive Components, Disk Drive Performance, Fundamental Laws Governing Disk Performance, Logical Components of the Host, Application Requirements and Disk Performance.

08 Hours

UNIT 2:

Data Protection, Intelligent Storage system, Direct-Attached Storage and SCSI: Implementation of RAID, RAID Array Components, RAID Levels, RAID Comparison, RAID Impact on Disk Performance, Hot Spares Components of an Intelligent Storage System, Intelligent Storage Array, Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces, Introduction to Parallel SCSI,

08 Hours

UNIT 3:

Storage Area Networks, NAS, IP SAN: Overview of Fiber Channel, The SAN and Its Evolution, Components of SAN, FC Connectivity, Fiber Channel Ports, Fiber Channel Architecture, Zoning, Fiber Channel Login Types, FC Topologies, General – Purpose Service vs. NAS Devices, Benefits of

NAS, NAS File I / O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. iSCSI, FCIP. **08 Hours**

UNIT 4:

Content-Addressed Storage, Storage Virtualization and Business Continuity: Fixed Content and Archives, Types of Archive, Features and Benefits of CAS, CAS Architecture, Object Storage and Retrieval in CAS, CAS Examples Forms of Virtualization, SNIA Storage Virtualization Taxonomy, Storage Virtualizations Configurations, Storage Virtualization Challenges, Types of Storage Virtualization. Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions. **08 Hours**

UNIT 5:

Backup and Recovery, Local Replication and Remote Replication: Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Process, Backup and restore Operations, Backup Topologies, Backup in NAS Environments, Backup Technologies. Source and Target, Uses of Local Replicas, Data Consistency, Local Replication Technologies, Restore and Restart Considerations, Creating Multiple Replicas, Management Interface, Modes of Remote Replication, Remote Replication Technologies, Network Infrastructure. **08 Hours**

Self-Learning Components: Case study: Replacing a server with storage Networks, Case Studies: Direct Access File System, General Parallel File System.

Text Books:

1. **Somasundaram Gnanasundaram, Alok Shrivastava:** "*Information Storage and Management"*, Second edition, Wiley India 2013.
2. **Ulf Troppens, Rainer Erkcns and Wolfgang Muller**, *"Storage Networks Explained"*, John Wiley & Sons, 2003.
3. **Robert Spalding,** *"Storage Networks - The Complete Reference"*, Tata McGraw Hill, 2011.
4. **Richard Barker and Paul Massiglia:** "*Storage Area Network Essentials ACompleteGuide to understanding and Implementing SANs*", Wiley India, 2006.
5. **Marc Farley:** "*Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems"*, Cisco Press, 2005.

E-Resource:

1. NPTEL Videos: nptel.ac.in/courses/106108058/
2. https://clickforacess.files.wordpress.com/2017/11/san-book.pdf -- (ISM Textbook PDF).

EC 743: Cryptography and Network Security

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 743	Cryptography and Network Security	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Encrypt and decrypt data using symmetric key and public-key ciphers
2. Analyse solutions for effective key management and distribution and conduct cryptoanalysis
3. Analyse and use cryptographic data integrity algorithms and user authentication protocols
4. Analyse the cause for network attacks and describe the working of various advanced security controls
5. Explore the attacks and controls associated with IP, transport-level, web and E-mail security
6. 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 1:

Overview: Computer Security Concepts, Security Attacks, Security Services and Security Mechanisms, OSI security architecture, Model for network security. Encryption Techniques: Symmetric cipher model, Substitution techniques, Transportation techniques, Rooter machine, Steganography, Problems. **08 Hours**

UNIT 2:

Block Ciphers and DES (Data Encryption Standards): Simplified DES, Block cipher principles, DES, Strength of DES, Block cipher design principles, Block cipher operation. **08 Hours**

UNIT 3:

Public Key Cryptography and RSA: Principles of public key cryptosystems, RSA algorithm, Problems. Other Public Key crypto Systems and Key Management: Key management, Diffie-Hellman key exchange, Elliptic curve arithmetic, Elliptic curve cryptography, Problems. **08 Hours**

UNIT 4:

Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hah Functions, Security of Hash functions and MAC's, Problems.

Digital Signature and Authentication Protocol: Digital signature, Authentication protocols, Digital signature standard. **08 Hours**

UNIT 5:

Electronic Mail Security: Pretty good privacy, S/MINE, Data compression using ZIP, Radix-64 conversion, PGP random number generator.

IP Security: Overview, IP security architecture, ESP (Encapsulating security pay load), Problems.

08 Hours

Self-Learning Components: Authentication Applications: Kerberos, X.509 authentication services. Firewalls: Firewall design principles, trusted systems, System viruses.

Text Books:

1. **William Stallings**, "*Cryptography and network Security – principles and practice*", 7th edition, Pearson Education(Asia)Pvt. Ltd. Pearson Education, 2017.
2. **Behrouz A. Forouzan**, **Debdeep mukhopadhyay**, "*Cryptography and Network Security*" second edition, Mcgraw-Hill Education, 2010.
3. **AtulKahte,"** *Cryptography and Network security*", 3rd Ed, McGrawhill Education(India), 2013

E-Resource:

1. https://nptel.ac.in/syllabus/106105031/
2. https://nptel.ac.in/courses/106105162/
3. https://onlinecourses.nptel.ac.in/noc18_cs07/preview
4. https://www.youtube.com/watch?v=p6w9RZ5PNho
5. http://rmd.ac.in/dept/it/notes/7/CNS/unit4.pdf

EC 744: Artificial Intelligence

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 744	Artificial Intelligence	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. To Apply a given AI technique to a given concrete problem
2. To Implement non-trivial AI techniques in a relatively large system
3. To understand uncertainty and Problem solving techniques.
4. To understand various symbolic knowledge representation to specify domains and reasoning tasks of a situated software agent.
5. To understand different logical systems for inference over formal domain representations, and trace how a particular inference algorithm works on a given problem specification.
6. To understand various learning techniques and agent technology.

UNIT 1

The Underlying assumption, AI Technique The Level of the model, Criteria for success, some general references, one final word and beyond. Problems, problem spaces, and search: Defining, the problem as a state space search, Production systems, Problem characteristics, Production system characteristics, Issues in the design of search programs, Additional Problems. Intelligent Agents: Agents and Environments, The nature of environments, the structure of agents. **08 Hours**

UNIT 2

Heuristic search techniques: Generate-and-test, Hill climbing, best-first search, Problem reduction, Constraint satisfaction, Mean-ends analysis. Knowledge representation issues: Representations and mappings, Approaches to knowledge representation, Issues in knowledge representation, The frame problem. Using predicate logic: Representing simple facts in logic, representing instance and ISA relationships, Computable functions and predicates, Resolution, Natural Deduction. Logical Agents: Knowledge –based agents, the Wumpus world, Logic-Propositional logic, Propositional theorem proving, Effective propositional model checking, Agents based on propositional logic **08 Hours**

UNIT–3

Symbolic Reasoning under Uncertainty: Introduction to nonmonotonic reasoning, Logic for nonmonotonic reasoning, Implementation Issues, Augmenting a problem-solver, Implementation: Depth-first search, Implementation: Breadth-first search. Statistical Reasoning: Probability and bayes Theorem, Certainty factors and rule-based systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy logic. Quantifying Uncertainty: Acting under uncertainty, Basic probability notation, Inference using full joint distributions, Independence, Bayes' rule and its use, The Wumpus world revisited. **08 Hours**

UNIT-4

Weak Slot-and-filter structures: Semantic Nets, Frames. Strong slot-and –filler structures: Conceptual dependency, scripts, CYC

Adversarial Search: Games, Optimal Decision in Games, Alpha-Beta Pruning, Imperfect Real-Time Decisions, Stochastic Games, Partially Observable Games, State-Of-The-Art Game Programs, Alternative Approaches, **08 Hours**

UNIT–5

Learning From examples: Forms of learning, Supervised learning, Learning decision trees, Evaluating and choosing the best hypothesis, The theory of learning ,PAC, Regression and Classification with linear models, Nonparametric models, Support vector machines, Ensemble learning. Learning Probabilistic Models: Statistical learning, learning with complete data, learning with hidden variables: The EM algorithm. **08 Hours**

Self-Learning Components: Speech Recognition, Classification using Adaboost, Face detection, and Neural Networks.

Text Books:

1. **Elaine Rich,Kevin Knight, Shivashanka B Nair:** *"Artificial Intelligence"*, Tata CGraw Hill 3rd Edition. 2013
2. **Stuart Russel, Peter Norvig: "***Artificial Intelligence A Modern Approach*", Pearson 3rd edition 2013.
3. **Nils J. Nilsson:** *"Principles of Artificial Intelligence"*, Elsevier, ISBN-13: 9780934613101
4. **Artificial Intelligence: A Modern Approach** by Stuart Russel, Peter Norvig, 2nd

Edition, Pearson Education, 2003.

5. **Artificial Intelligence**, by Elaine Rich, Kevin Knight, Shivashankar B Nair: Tata MCGraw Hill 3rd edition. 2013**.**
6. **Artificial Intelligence** by George F Luger, 5th Edition Pearson Education, 2009.

E Resource:

1. https://www.youtube.com/playlist?list=PL9zFgBale5fug7z_YlD9M0x8gdZ7ziXen
2. https://www.youtube.com/playlist?list=PLxCzCOWd7aiHGhOHV-nwb0HR5US5GFKFI
3. https://www.youtube.com/playlist?list=PLUl4u3cNGP63gFHB6xb-kVBiQHYe_4hSi

EC 745: Advanced Embedded Systems

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 745	Advanced Embedded Systems	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Understand the major components that constitute an embedded system.
2. Apply contemporary techniques for Hardware-Software co-design of embedded systems for Real time applications using RTOS.
3. Demonstrate the knowledge about the basic structure of embedded systems.
4. Develop familiarity with tools, used to develop in an embedded environment.
5. 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 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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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. **08Hours**

UNIT 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. **08 Hours**

UNIT 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? **08 Hours**

Self-Learning Components: RTOS scheduling, Device Drivers.

Text Books:

1. **Raj Kamal:** "Embedded *Systems Architecture, Programming and Design*", 2nd Edition, TMH, 2008.
2. **Shibu K V:** *"Introduction to Embedded Systems"*, 2ndEdition, TMH, 2017.
3. **James K Peckol:** "*Embedded Systems- A Contemporary Tool*" John Wiley, 2008.

E - Resource:

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

EC 746: Electronics Systems Design and Manufacturing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 746	Electronics Systems Design and Manufacturing	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Design complete electronic systems/subsystems, adhering to various industrial standards and Laws.
2. Able to manage 'Design for Manufacturing' jargon as bottleneck and necessity.
3. Able to economically design and manufacture a subsystem, system, or a product and launch within the time frame.
4. Able to test the product/system, by proposing test procedures and methods.
5. Able to assess market segments and propose solutions as Electronic products.

UNIT 1:

Introduction: HOM(History of manufacturing with special emphasis to India) of electronic systems, survey of Industrial standards (Manufacturing, safety, IEEE, Industrial associations standard etc..)

08 Hours

UNIT 2:

Design of electronic systems: Conceptual product development, mechanical design, Electrical design (Electronic hardware, wiring , power-supply , other subsystems), software design. **08 Hours**

UNIT 3:

Testing: Agency compliance testing, Analytical Lab testing, Envirnomental testing, Functional testing.

08 Hours

UNIT 4:

Manufacturing: PCB Design using free tools(single and Multilayer), PCB assembly(rigid,flexible), SMD, testing and packaging. **08 Hours**

UNIT 5:

Mini project **08 Hours**

Text Books :

Electronic design magazines and journals and Internet resources

E Resource:

1. https://www.youtube.com/watch?v=1Q3iHfX75K4&list=PLD50A0FB75B98EDA3
2. https://www.youtube.com/watch?v=4Zc01grv0wc&list=PLKFw3DT5ZiEgk6zZ-UcosxIg5PRd67BF_
3. https://www.youtube.com/watch?v=emdSUV2ZIEE&list=PLgzsL8klq6DIAY0e-d3Lnd_HmxJYdCp6K

VIII Semester

EC 810: Mixed Mode VLSI Design

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 810	Mixed Mode VLSI Design	4	0	0	4	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the working principle of analog circuits.
2. Analyze the transient, AC and DC response for analog CMOS circuits.
3. Evaluate the performance parameters of analog and mixed signal CMOS circuits.
4. Design and develop the analog CMOS circuits for linear applications using simulation tool.

UNIT 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. **10 Hours**

UNIT 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. **10 Hours**

UNIT 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. **11 Hours**

UNIT 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. **11 Hours**

UNIT 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. **10 Hours**

Self-Learning Components: Bandgap Refernces and Switched capacitor Circuits: General Considerations, Supply Independent biasing, PTAT Current Generation, and Switched Capacitor Amplifiers.

Data Converter Architecturres: DAC & ADC Specifications, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Pipeline ADC, Integrating ADC.

Text Books:

1. **Behzad Razavi:** *"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.
3. **R. Jacob Baker:** "CMOS*: MIXED-SIGNAL CIRCUIT DESIGN,"* IEEE Press Series on microelectronics systems, A John Wiley & Sons, Inc., Publication 2008.

E-Resource

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**

EC 821: Digital Compression Techniques

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 821	Digital Compression Techniques	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Acquire knowledge on fundamental concepts of information theory, lossless compression and coding techniques.
2. Apply coding techniques like Huffman, Adaptive Huffman and Arithmetic coding for data compression.
3. Apply static and adaptive dictionary techniques for lossless compression and illustrate the basic mathematics of lossy compression techniques.
4. Illustrate the comprehensive knowledge on quantization techniques and transform coding.
5. Acquire knowledge on concept of sub-band coding and wavelet transforms for 2D data compression and ability to apply them**.**
6. Complete a group task, demonstrate abilities in oral/ written communication and in collaborative learning

UNIT 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. **08 Hours**

UNIT 2:

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.

08 Hours

UNIT 3:

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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 5:

Sub-band Coding: Sub-band coding, analysis, quantization, coding, and synthesis, Wavelets: Multi-resolution analysis and scaling function, implementation using filters, image compression using wavelets, JPEG 2000. **08 Hours**

Self-Learning Components: Embedded Zero tree Coder, Set partitioning in Hierarchical tress for image compression, Image Compression using Adaptive Wavelet Filters, Video Compression, Video Signal Representation, The MPEG-1 Video Standard 18.9, The MPEG-2 Video Standard—H.262

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.

3. **Mark Nelson and Jean-Loup Gailly**, "*The Data Compression Book*", 2nd Edition, Wiley, 1995

E-Resource

1. **https://nptel.ac.in/courses/117105081**
2. **https://nptel.ac.in/courses/106105032/24**

EC 822: Low Power VLSI Design

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 822	Low Power VLSI Design	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the need for low power and identify the source of power dissipation in VLSI circuits.
2. Explain the second order effects of MOS transistor characteristics.
3. Recognize the critical requirements for to implement low power VLSI circuits.
4. Apply the different design techniques for low power CMOS circuits for various applications.
5. Design and evaluate the low power design techniques to implement at different hierarchy of VLSI design using simulation tool.

UNIT 1:

Introduction - Need for low-power VLSI chips, Sources of power dissipation, designing for low-power, Physics of power dissipation in CMOS circuits, low-power design limits. **08 Hours**

UNIT 2:

Power Estimation - Modeling of signals, Signal probability calculation, Probabilistic techniques for signal activity, Statistical techniques, Estimation of glitching power, Sensitivity analysis, power estimation using input vector compaction.

Circuit reliability, Power estimation at circuit level, High-level power estimation, Information theory based approaches, Estimation of maximum power **08 Hours**

UNIT 3:

Synthesis for Low power - Behavioral level transforms, Logic level optimization, Circuit level transforms. **08 Hours**

UNIT 4:

Design and Test of Low - voltage CMOS circuits - Circuit design style, Leakage currents in deep submicron transistors, Deep submicron device design issues Key to minimizing SCE, Low-voltage current design techniques, Testing deep submicron ICs with elevated intrinsic leakage, Multiple supply voltages. **08 Hours**

UNIT 5:

Software Design for Low Power - Sources of software power dissipation, Software power estimation. Software power optimizations, Automated low-power code generation, co-design for low-power, Recent advances in low power design. **08 Hours**

Self-Learning Components: Modeling for Designing in Deep Submicron Technologies, Low-Power Arithmetic Operators, Circuits Techniques for Dynamic Power Reduction

Text Books:

1. **Kaushik Roy & Sharat Prasad:** *"Low Power CMOS VLSI DESIGN"* John Wley & Sons Inc 2000.
2. **Gary K Yeap: "***Practical Low Power Digital VLSI Design"* Kluwer Academic Publisher, 1998.
3. **Christian Piguet:** *"Low Power CMOS circuits Technology, logic design and CAD tools"*, CRC Press 2006.

E Resource:

1. https://www.youtube.com/playlist?list=PL1QW4Xb9ORKqsv4vHK0WiQIGFUnzZa0ii
2. https://www.youtube.com/playlist?list=PLTEh-62_zAfHmJE-pcjgREKiKyPSgjkxj

EC 823: Wireless Sensor Networks

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 823	Wireless Sensor Networks	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Acquire the fundamental knowledge about the architecture of wireless sensor networks.
2. Demonstrate the working of flow control and Error control MAC protocols of WSN.
3. Explain the principles of data transmission, routing protocols and its challenges.
4. Analyze the challenges and design issues of transport layer and the QOS.
5. Explain the Security issues and applications of ad hoc and wireless sensor networks.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

UNIT 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.

08 Hours

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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 Wireless Networks.

APPLICATIONS of WSNs: Ultra wide band radio communication, Wireless fidelity systems, Home automation, smart metering Applications. **08 Hours**

Self Learning Components: 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. **Kazem Sohraby, Daniel Minoli, & Taieb Znati**, "*Wireless Sensor Networks- Technology, Protocols, and Applications*", John Wiley, 2007.
3. **Waltenegus Dargie and Christian poellabauer**, "*Fundamentals of Wireless Sensor Networks*", Wiley, 2010.
4. **C. Siva Ram Murthy and B.S.Manoj** –"*Ad Hoc Wireless Networks: Architectures and Protocols*", PHI, 2004.

E-Resource:

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

EC 824: Wavelet Transform

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 824	Wavelet Transform	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Apply the concept of Vectors, Basis Sets for Signal Representation.
2. Analyze discrete and continuous time signals using Wavelets
3. Evaluate efficient computation techniques for DWT.
4. Use modern tools to apply wavelets for audio and image processing.

UNIT 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, Problem solving.

08 Hours

UNIT 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, Daubechies wavelets, Problem solving **08 Hours**

UNIT 3:

Construction of continuous wavelets (in time domain and frequency domain), Filter implementation, wavelets with compact support, Examples: beta wavelet, Mexican hat wavelet, Shannon wavelet, Biorthogonal wavelets. **08 Hours**

UNIT 4:

Applications: Image compression, feature extraction, audio masking, denoising, pattern recognition.

08 Hours

UNIT 5:

Lifting wavelet scheme: Primal lifting, dual lifting, Polyphase representation, Laurent polynomials, Lifting properties and applications. **08 Hours**

Text Books

1. **Michael Frazier,** *"An Introduction to Wavelets through Linear Algebra"*, Springer Edition. 2013 Reprint.
2. **Raghuveer M. Rao, Ajit Bopardikar,** "*Wavelet Transforms: Introduction to Theory and Applications"*, Pearson Publication. 2014.
3. **K. P. Soman, K I Ramachandran, N G Resmi**, "*Insight into Wavelets:* From Theory to Practice", PHI Eastern Economy Edition, 2014.

E Resource:

1. https://www.youtube.com/watch?v=c4s5X-Bm2Wc&list=PLUYV0LEDKN9CQ-HT33K8ED6-f2tlxcN0Q
2. https://www.youtube.com/watch?v=fYG0avmRokg&list=PLzneuU2STpz1B09rXYy7WQqQtBFOhaxlO

EC 825: Hybrid Vehicles

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 825	Hybrid Vehicles	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. Explain the importance and the basics of hybrid vehicles
2. Explain the architecture of hybrid electric vehicle and energy storage technologies
3. Analyze various electric drives of HEV
4. Design vehicle control models used in automobile
5. Design and demonstrate the models of automobile using simulation tool.

UNIT 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. **06 Hours**

UNIT 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. **10 Hours**

UNIT 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) **10 Hours**

UNIT 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. **08 Hours**

UNIT 5:

Power Electronics Converters: Power Electronics Converters, DC/DC Converters, Cell Balancing Converters. **06 Hours**

UNIT 6:

Vehicle controls – cruise control, Vehicle controls – active suspensions active suspensions antilock braking– traction control vehicle stability & rollover four wheel steering, active safety.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV)

08 Hours

Self-Learning Component: 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.
3. **Crouse and Anglin** *"Automotive Mechanism"*, 9th Edition. Tata McGraw-Hill, 2003.
4. **Newton, Steeds and Garet**, *"Motor vehicles"*, Butterworth Publishers, 1989.
5. **Srinivasan.S,** *"Automotive Mechanics"* 2nd edition, 2003, Tata McGraw-Hill.
6. **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

EC 826: Mobile Computing

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 826	Mobile Computing	3	0	0	3	50	50	100

Course outcome: At the end of the course, the student should be able

1. **Summarize** the evolution of mobile communication and **expound** the concept of mobile computing related to mobile operating systems and devices.
2. **Analyze** the different inter-networking challenges and **evaluate** the solutions in wireless mobile data networks with respect to mobile IP Network Layers.
3. **Assess** the Wireless Application Protocol (WAP) for Internet access and value-added services.
4. **Demonstrate** creative skills in design, layout and interactivity of WAP pages using wireless mark-up languages.
5. **Delineate** and **exemplify** the different mobile application development frameworks to the development of a mobile application.
6. **Simulate** real time computing problems and **develop** a mobile application using modern software tools through group projects and give oral presentation with documentation.

UNIT 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. **08 Hours**

UNIT 2:

Data perspective:CDPD, GSM Architecture and data services, CDMA, 3G, 4G, VoIP, Wireless Local Loop (WLL) system, Wireless Telephony Access. **08 Hours**

UNIT 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. **08 Hours**

UNIT 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. **08 Hours**

Unit 5:

Introduction to mobile development process. Architecture, design and technology selection for mobile application. Mobile application development hurdles. Testing mobile applications. **08 Hours**

Self-Learning Component: Convergence of Internet, digital communication and computer networks, Architecture of oxygen OS, BlackBerry 10, Tizen and Sailfish OS,Personal Area Network: Bluetooth and ZigBee, Mobile Application Languages – JAVA, J2ME and JAVACARD, Application of XML language to develop a mobile application, Distributed file system for mobile environment, Smartphone-based platform architectures and applications. **(References: Pervasive and Mobile Computing - Journal – Elsevier, IEEE Transactions on Mobile Computing, International Journal of Wireless and Mobile Computing, International Journal of Wireless and Mobile Computing and Journal of Mobile Computing, Communications & Mobile Networks)**

Text Books:

1. **Raj Kamal**, *"Mobile Computing"*, Second Edition, Oxford University Press, 3rd Edition, 2018.
2. **Prasant Kumar Pattnaik and Rajib Mall,** *"Fundamentals of Mobile Computing"*, Prentice-Hall of India Pvt. Ltd, 2nd Edition, 2015.
3. **Ashoke K Talukder, Hasan Ahmed and Roopa R Yavagal**, *"Mobile Computing"*, Tata Mc Graw Hill, 2nd Edition, 2010
4. **Reza B'Far,** *"Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML"*, Cambridge University Press, 2009
5. **Yi Bing Lin and ImrichChlamtac**, *"Wireless and Mobile Networks Architecture"*, John Wiley, 3rd Edition, 2008.

E Resource:

1. https://www.youtube.com/watch?v=NmLl_1iV-dE&list=PLPRthuw8Et1epkTZicuwxLETjjkpRy3-R
2. https://www.youtube.com/watch?v=OxdUs9E8Aps&list=PLA0JjJ0bkQ4w2Tp-nF25sm8hmBsQZr0eg
3. https://www.youtube.com/watch?v=5MoIg5lWLXA
4. https://www.youtube.com/watch?v=tt1-Ohe9QQU
5. https://www.youtube.com/watch?v=Rjluns-AEnc

EC 84P: Project Work Phase II

Course code	Course title	Hours/week			Credits	CIE Marks	SEE Marks	Total Marks
		L	T	P				
EC 84P	Project Work Phase II	0	0	6	6	50	50	100

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

1. Function effectively in a team contributing constructively for implementation and successful completion of the project with an efficient management of time and resource.
2. Fabricate/implement the project adopting necessary tools and techniques adhering to ethical issues and carry out a performance evaluation based on prevailing trends.
3. 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.
4. Prepare a comprehensive document and give an effective presentation making use of modern tools, adhering to standard practices and ethics.

PHASE	PARAMETERS FOR EVALUATION	M – 1	Total	M – 2	Total	M – 3	Total	M – 4	Total
Phase – 1	1. Presentation of the problem								
	2. Clarity and concepts								
	3. Innovative approach								
	4. Scheduling the work and adherence								
Phase – 2	1. Progress as per schedule								
	2. Fabrication details and status								
	3. Presentation and intermediate results								
Phase – 3	1. Demonstration of working								
	2. Completion of the work								
	3. Presentation of the work								
	4. Queries								
	5. Innovation and application								
Report	1. Adhering to standard format								
	2. Language and grammar								
	3. Clarity in presentation organization								
Total		**M – 1**		**M – 2**		**M – 3**		**M – 4**	