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

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

SCHEME III TO VIII SEMESTER: 2017-2018

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SYLLABUS III & IV SEMESTER: 2017-2018

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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

Syllabus

For those who are admitted during 2016-17

Vision

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

Mission

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

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

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

SEMESTER	CREDITS
I	25.0
II	25.0
III	25.5
IV	27.0
V	25.5
VI	27.0
VII	24.0
VIII	21.0
TOTAL	200.0

2 a. PROGRAM OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

11. **Lifelong Learning**: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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

2b. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

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

2c. PROGRAM SPECIFIC OUTCOMES (PSO'S)

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

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

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

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of teaching and examination for B.E (E&CE)

SEMESTER - I

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/ Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	MA110	Engineering Mathematics – I (Advanced Calculus)	Mathematics	3	1	0	4	5	50	50	3
2	CH110	Engineering Chemistry	Chemistry	4	0	0	4	4	50	50	3
3	EC110	Electronic Devices and Circuits	E&C	4	0	0	4	4	50	50	3
4	CS110	Programming in C	CS/IS	4	0	0	4	4	50	50	3
5	ME120	Computer Aided Engineering Graphics	Mech/IP	2	0	2	4	4	50	50	3
6	CH12L	Engineering Chemistry Lab	Chemistry	0	0	1.5	1.5	3	50	-	-
7	CS12L	C Programming Laboratory	CS	0	0	1.5	1.5	3	50	-	-
8	HU110	Innovation studies	Humanities	2	0	0	2	2	50	50	-
9	HU130	Kannada	Humanities	-	-	-	-	2	50	-	-

TOTAL				25	31	450	300	15

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SEMESTER – II

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	MA210	Engineering Mathematics – II (Multivariable Calculus)	Mathematics	3	1	0	4	5	50	50	3
2	PH210	Engineering Physics	Physics	4	0	0	4	4	50	50	3
3	CV220	Elements of Civil Engineering and Engineering Mechanics	Civil	4	0	0	4	4	50	50	3
4	EE210	Basic Electrical Engineering	E&EE	4	0	0	4	4	50	50	3
5	ME220	Mechanical Engineering Science	Mech/IP	4	0	0	4	4	50	50	3
6	PH22L	Engineering Physics Lab	Physics	0	0	1.5	1.5	3	50	-	-
7	EC21L	Electronic Devices and Circuits Lab	ECE	0	0	1.5	1.5	3	50	-	-

8	HU220	Professional Communication and Technical Documentation / Functional English	Humanities	2	0	0	2	2	50	50	1.5
TOTAL							25	29	400	300	15

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SEMESTER – III

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/ Wk	% Weightage		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	MA310	Fourier series, Integral Transforms and Applications	Mathematics	4	0	0	4	4	50	50	3
2	EC310	Circuit Theory and Analysis	E&CE	3	1	0	4	5	50	50	3
3	EC320	Sensors and Actuators	E&CE	3	1	0	4	5	50	50	3
4	EC330	Analog Electronic Circuits	E&CE	3	0	1	4	5	50	50	3
5	EC340	Digital Electronic Circuits	E&CE	3	0	1	4	5	50	50	3

6	EC350	Principles of Communication Systems	E&CE	4	0	0	4	4	50	50	3
7	EC31L	Simulation Lab	E&CE	0	0	1.5	1.5	3	50	-	-
8	HU320	Environmental Studies	ENV	-	-	-	-	2	50	-	-
TOTAL							25.5	33	400	300	18

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Scheme of teaching and examination for B.E (E&CE)

SEMESTER – IV

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/ Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	MA411	Probability, Random Variables and Stochastic processes	Mathematics	4	0	0	4	4	50	50	3
2	EC410	Linear Integrated Circuits	E&CE	3	0	1	4	5	50	50	3

3	EC420	Switching Systems and Access Networks	E&CE	4	0	0	4	4	50	50	3
4	EC430	Signals and Systems	E&CE	3	1	0	4	5	50	50	3
5	EC440	Digital System Design	E&CE	3	0	1	4	5	50	50	3
6	EC450	Engineering Electromagnetics	E&CE	3	1	0	4	5	50	50	3
7	EC460	Data Structures and Algorithms	E&CE	3	0	0	3	3	50	50	3
8	HU410	Constitution of India and Professional Ethics	Humanities	-	-	-	-	2	50	-	-
TOTAL							27	33	400	350	21

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SEMESTER – V

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weightage		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	

1	EC 510	Analog Communication	E&CE	3	0	1	4	5	50	50	3
2	EC 520	Microcontrollers & Applications	E&CE	3	0	1	4	5	50	50	3
3	EC 530	Control Systems	E&CE	3	1	0	4	5	50	50	3
4	EC 540	Digital Signal Processing	E&CE	3	1	0	4	5	50	50	3
5	EC 550	Operating Systems	E&CE	3	1	0	4	5	50	50	3
6	EC560	Linear Algebra & Applications	E&CE	4	0	0	4	4	50	50	3
7	EC 51L	DSP Lab	E&CE	0	0	1.5	1.5	3	50	-	-
TOTAL							25.5	32	350	300	18

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SEMESTER - VI

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/ Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	EC 610	Digital Communication	E&CE	3	1	0	4	5	50	50	3
2	EC 620	Computer Networks	E&CE	4	0	0	4	4	50	50	3
3	EC 630	CMOS VLSI circuits	E&CE	3	0	1	4	5	50	50	3
4	EC 640	Optical fiber communication	E&CE	4	0	0	4	4	50	50	3
5	EC 65X	Department Elective	E&CE	3	1	0	4	5	50	50	3
6	EC 66X	Department Elective	E&CE	3	1	0	4	5	50	50	3
7	EC 61L	Advanced Communication Lab	E&CE	0	0	1.5	1.5	3	50		
8	EC 62L	Design & Implementation Lab	E&CE	0	0	1.5	1.5	3	50		
TOTAL							27	34	400	300	18

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SEMESTER – VII

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	EC 710	Microwave and Antennas	E&CE	4	0	0	4	4	50	50	3
2	EC 720	Mobile Communication	E&CE	3	1	0	4	5	50	50	3
3	EC 730	Power Electronics	E&CE	3	0	1	4	5	50	50	3
4	EC 74X	Department Elective	E&CE	3	1	0	4	5	50	50	3
5	EC 75X	Open Elective	E&CE	3	1	0	4	5	50	50	3
6		Foreign Language	E&CE	-	-	-	-	2	-	-	-
7	EC71L	Computer Networks Lab	E&CE	-	-	1.5	1.5	3	50	-	-
8	EC 76P	Project Phase I	E&CE	0	0	2.5	2.5	5	50	-	-
TOTAL							24	34	350	250	15

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SEMESTER - VIII

Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/ Wk	% Weight		SEE Duration in Hours
				L	T	P	Total		CIE	SEE	
1	EC 810	Entrepreneurship and Management	E&CE	4	0	0	4	4	50	50	3
2	EC 82X	Department Elective	E&CE	4	0	0	4	4	50	50	3
3	EC 83X	Open Elective	E&CE	4	0	0	4	4	50	50	3
4	EC 84P	Project Phase II	E&CE	0	0	7	7	7	70	30	3
5	EC 85P	Publication/Industry Course/Certified online course	E&CE	-	-	-	2	2	50	-	-
TOTAL							21	21	270	180	12

Department of Electronics and Communication Engineering, SJCE, Mysuru

Subject Name & Code	**Electronics Devices and Circuits - EC 110**
No. of Teaching Hours: 50	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks: 50**

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

1. Analyze the characteristics of semiconductor diode, load line and its applications.
2. Analyze the characteristics of transistors (BJT, JFET and MOSFET).
3. Realize analog and digital logic circuits using BJT and MOSFET.
4. Analyze the working of Op-Amp and illustrate its applications.
5. Explain the need and usage of testing and measuring instruments.

UNIT 1

Semiconductor devices: Semiconductor diode Construction, biasing, characteristics, Load line analysis, applications (Rectifier, Clipping circuits and clamping circuits using diode), Zener diode: characteristic, Zener as voltage regulator.

10 hours

UNIT 2

Bipolar Junction Transistor: Principle, modes of Operation, configurations, Characteristics, biasing (DC analysis of CE configuration), bias stabilization, application: As a switch, as an amplifier.

10 hours

UNIT 3:

JFET: Construction (n-channel and p-channel), Operation, Characteristics, MOSFET: Construction, operation, characteristics of nMOS and pMOS enhancement and depletion mode application: Realization of logic gates (Inverter, NAND and NOR gates).

10 hours

UNIT 4

Op-amps & its Applications: Differential amplifier, terminal characteristics of Op-amp, virtual ground concept, application: Inverting amplifier, Non-inverting amplifier, adder, Subtractor, Integrator, Differentiator and unity gain amplifier (buffer).

Digital Logic: Binary arithmetic, Logic gates, Boolean algebra: SOP and POS, Simplification and realization, Combinational circuit application: Adders and Subtractor. **10 hours**

UNIT 5

Testing and measuring instruments: Basic construction (Block diagram approach) laboratory usage, advanced models of function generator, multimeter and CRO.

10 hours

References

1. **Robert L. Boylstad and Louis Neshelsky: "***Electronic Devices and Circuit theory",* 11th edition, Pearson, 2013.
2. **Floyd and Jain: "***Digital fundamentals",* 8th edition, Pearson Education 2007.
3. **H S Kalsi: "***Electronic Instrumentation"*, 3rd edition, McGraw Hill Education, 2014.

Subject Name & Code	Electronics Device and circuit lab - EC21L
No. of Teaching Hours: 36	Credits : 0:0:1.5 L-T-P
CIE Marks : 50	SEE Marks : -

Objectives

With the prerequisites of electronic devices and circuit theory (EC110), this course (EC21L) will make an adequate preparation for the student in the lab to handle electronic devices and components, understand the operational knowledge of basic test and measuring instruments, practical aspects, specifications and ratings of each devices, building basic circuits and characterizing devices, design and working with basic circuits using operational amplifiers, design and working with basic digital circuits.

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

1) Demonstrate a comprehensive background information related to the experiment and be able to read, interpret data sheets, select parameters and design as per given specifications
2) Construct the experimental setup, carry out a systematic conduction, and record the observations by properly managing time and resources.
3) Verify the knowledge of theory with experiments through an effective communication.
4) Document the procedure and the outcome of the experiment and prepare a report as per given guidelines.
5) Work effectively as a team member and come out with a conclusive interpretation of obtained outcomes.

Introduction: Operation and settings for basic instruments like CRO, multi meter, signal generator, power supply etc. Identification, specifications and testing of passive and typical active devices and components.

1. Experimental determination of V-I characteristics of junction diode (forward) and point contact diode (reverse). Measurement of respective resistances from the characteristics.

2. Experimental determination of Zener as a voltage regulator. Design and testing of voltage regulator using 3 pin IC regulator.

3. Design and testing of half wave and full wave rectifiers with and without C filter.

4. Testing of clipping (series, shunt, parallel) circuits.
5. Testing of clamping circuits.
6. Determination of input and output characteristics of BJT, determination of transistor parameters.
7. Determination of JFET parameters from Characteristics (drain and trans-conductance) and bandwidth from frequency response of FET amplifier.
8. Design and testing of basic OPAMP circuits (Inverting, non-inverting, voltage follower, adder, subtractor).
9. Testing of basic OPAMP circuits (Integrator, Differentiator).
10. Building and testing of simple combinational logic functions.

Beyond Syllabus

1. Design and verify experimentally the performance of Precision rectifiers.
2. Simplify and realize the Boolean expression (SOP / POS form) using logic gates.

Subject Name & Code	Circuit Theory and Analysis - EC310
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits: 3:1:0 L-T-P
CIE Marks : 50	SEE Marks : 50

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

1. Use network solution techniques, like nodal analysis and mesh analysis, and matrix methods and apply source transformation and source shifting techniques to solve circuit problems.
2. Apply network theorems for circuit analysis and design.
3. Analyze series and parallel resonant circuits and apply them to actual requirements and compute initial conditions for current and voltage in first and second order RLC circuits.
4. Apply advanced techniques such as Laplace transform and Fourier series for solving circuit problems.
5. Represent two – port networks with different sets of two-port parameters and analyze them.
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 concepts

Introduction, Network terminologies, Review of KVL & KCL, Energy sources – ideal and practical, Source Transformations, Mesh Analysis of DC & AC circuits, Circuits with independent voltage sources only Mesh analysis – circuits containing independent current sources & 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 & network reduction using them, Source Shifting , problems.

8 Hours

UNIT 2: Network Theorems

Superposition theorem, problems. Thevenin's theorem as applied to AC & DC circuits, Norton's theorem as applied to DC & AC circuits, Maximum power transfer theorem as applied to DC & AC circuits, Mill man's theorem, applications & problems.

8 Hours

UNIT 3: Resonance and Initial Conditions

Series resonance, resonant frequency, reactance curves, voltage & current variable with frequency, Selectivity & bandwidth, Q – factor, circuit magnification factor Selectivity with variable C & variable L Parallel resonance, resonant frequency, impedance, selectivity, bandwidth Maximum impedance conditions with C, L, & f variable, current & Q – factor.

Need, Initial conditions in R, L, & C elements. Final conditions and Geometrical interpretation of derivatives, Procedure to evaluate initial conditions. Initial state of a network.

8 Hours

UNIT 4: Circuit Analysis using Laplace Transforms and Fourier series

Review of Laplace transforms, Natural & Forced responses, Advantages of LT techniques, Modeling R, L, & C in s – domain, DC transients, Step response of RC, RL & RLC circuits, Impulse & Pulse response of RC & RL circuits & AC transients, Circuit analysis with LT using partial fraction expansion & convolution integral.

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

8 Hours

UNIT 5: Network Functions and Two Port parameters

Concept of complex frequency, Network functions for one & two – port networks. Poles & zeros of network functions, Restrictions on pole & zero locations for driving point functions & 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.

8 Hours

References:

1. **J. David Irwin, Robert M Nelms**, "*Engineering Circuit Analysis*", 10 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.

Subject Name & Code	**Sensors & Actuators - EC320**
No. of Teaching Hours: 40, **Tutorials: 12 Sessions.**	**Credits : 3:1:0 L-T-P**
CIE Marks : 50	**SEE Marks: 50**

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

1. Explain the characteristics of electrical and electronic measuring instruments.
2. Demonstrate the knowledge on working principles of different transducers and their applications.
3. Explain and analyse the working principles of sensors & actuators and explore their applications.
4. Develop and exhibit basic programming skills in Virtual Instrumentation.
5. Implement a system using sensor and instrumentation configuration for practical application and its verification
6. Work in a team, complete the assignment and present the results in written and oral forms.

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.

08 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.

08 hours

UNIT 3: Virtual Instrumentation

Introduction, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow. VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case

and sequence structures, formula nodes, local and global variables, string and file I/O.

08 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, Microsensors.

08 hours

UNIT 5: Actuators

Functional components of an actuator, Actuator as a system component, Intelligent & Self sensing actuators, micro actuation, MEMS with micro actuators, Application examples (Automatic anti-lock braking systems).

08 hours

SLE: Medical Sensors and Wearable's and its applications.

References

1. D.V.S. Murthy: ***Transducers and Instrumentation***, 2nd Ed, PHI Ltd, 2014
2. Tai-Ran Hsu: **MEMS & Microsystems Design Manufacture and nanoscale Engineering**, 2nd Ed, Tata McGraw Hill, 2008.
3. Dr. S Sumathi, P. Surekha: ***LabVIEW based Advanced Instrumentation Systems***, Springer publication 2007.
4. Hartmut Janocha: ***Actuators Basics and Applications***, Springer publication 2013
5. D Patranabis: ***Sensors and Transducers*** 2nd Ed, PHI Ltd, 2003.

E-Resource

1. Video Lecture: http://nptel.ac.in/courses/112103174/3

Subject Name & Code	Analog Electronic Circuits - EC330
No. of Teaching Hours: 40, Practical: 12 Sessions.	Credits: 3:0:1 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Develop models of BJT, analyze and design BJT amplifiers.
2. Develop small signal model of FET, analyze and design single stage FET amplifiers.
3. Analyze and evaluate BJT and FET amplifiers at low and high frequencies using appropriate models and theorems.
4. Explain the concepts of feedback, apply them to the analysis and design of amplifiers and oscillators.
5. Explain the classification of power amplifiers and their operation, analyze and evaluate their performance.
6. Carry out a group task making use of simulation and analytical tools, document and give an effective presentation.

UNIT 1: BJT AC analysis

BJT modeling, r_e model, hybrid model, hybrid π model, CE fixed bias, Voltage divider bias and emitter bias configurations, emitter follower, CB Configuration, cascaded systems Darlington connection, feedback pair, current mirror, current source.

08 Hours

UNIT 2: FET AC analysis

JFET Small Signal model, JFET Fixed bias, Self bias, Voltage divider bias configurations, source follower common gate configuration, design of FET amplifier, E-MOS and D-MOS amplifiers.

08 Hours

UNIT 3: BJT and FET Frequency response

General frequency considerations, low frequency response of BJT and FET amplifiers, Miller effect capacitance, High frequency response of BJT and FET amplifiers, multistage effects.

08 Hours

UNIT 4: Feedback and oscillators

Concept of feedback, feedback topologies, practical feedback circuits, 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, power transistor heat sinking, class C and class D power amplifiers.

08 Hours

References

1. **Robert Boyelstad :** Electronic Devices and circuit theory, 11th edition, Pearson, 2015.
2. **Jacob Millman,ChristosHalkias, Chetan Parikh:** Millman's Integrated Electronics, 2nd Edition, 2009.
3. **Adel S Sedra and Kenneth C Smith:** Micro Electronic circuits; Theory and applications, 7th Edition, 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/

Analog Electronics Lab

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.

Subject Name & Code	**Digital Electronic Circuits - EC340**
No. of Teaching Hours: 40, **Practical: 12 Sessions.**	**Credits : 3:0:1 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Simplify Boolean expressions using various reduction techniques.
2. Analyze and design combinational circuits.
3. Acquire knowledge on the working principles of digital IC's and design of programmable logic circuits.
4. Analyse design and evaluate sequential circuits.
5. Simulate digital circuits using a suitable tool.
6. Work effectively as a member/leader in teams to complete the assigned tasks and present the results in an impressive manner.

UNIT 1

Introduction to K-maps basis for simplification. Four, five and six variables K-maps, Simplification procedure. Quine-McClusky method: Introduction, Decimal method of generation of PI's PI chart to generate EPI's.

SLE: Map extend variables.

08 hours

UNIT 2

Design of combinational logic circuits using MSI components: Design principles of parallel adders/subtractors, carry look ahead adders and decimal adders. Comparators: a general n-bit comparator, Logic design using multiplexers and demultiplexers, Decoders, encoders and priority encoders.

SLE: Design of half/full adders and half/full subtractors.

08 hours

UNIT 3

Logic design using PLD's: PROM's, PAL's and PLA's: Introduction, terminology and notation, Principles and logic design using each PLD's: IC Logic Families: Digital IC terminology, TTL logic family circuit, characteristics, loading, Fan-out, tri-state and open collector TTL.

SLE: IC interfacing: driving each other.

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08hours

UNIT 4

Flip flops and their applications, SR latch switch de-bouncer gated latch, Master slave SR and JK flip flops, Edge triggered D flip flop and JK flip flop characteristic equations, Conversion of one flip flop to other type.

SLE: Setup and hold times.

08 hours

UNIT 5

Registers and counters, Design of binary ripple and synchronous counters of arbitrary modulo using different flip flop, Comparison of ripple and synchronous counters parallel carry and ripple carry, Shift registers of different kinds such as uni and bidirectional, universal shift registers, Sequential logic design: Introduction to Mealy and Moore models.

SLE: State diagrams, excitations and transition tables.

08 hours

References

1. **Donald Givone,** "*Digital principles and design*", TMH-2008.
2. **Morris Mano, Charles Kime, "***Logic and computer design fundamental*", Pearson New 4th International Edition, 2017.
3. **Thomas L. Floyd and R.P. Jain**, "*Digital Fundamentals*", 8th Edition, Pearson education, 2009.
4. **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/117105080/2

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 and magnitude comparators.
7. Implementation of i) priority encoders and ii) LED decoder driver circuit.
8. Implementation and verification of truth table for J-K flip-flop, Master-slave J-K flip-flop, D flip-flop 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

Subject Name & Code	**Principles of Communication Systems - EC350**
No. of Teaching Hours: 50	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks: 50**

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

1. Trace the developments and importance of electronic communication and explain the concepts and working principles of communication systems.
2. Analyse and exhibit the knowledge related to the fundamental principles of Analog and Digital communication.
3. Demonstrate the fundamental principle, analyse and evaluate different transmission media.
4. Demonstrate knowledge of Principles of Multiplexing and apply them to communication system analysis.
5. Solve numerical problems and use mathematical tools to demonstrate the ability to apply concepts to real life examples of communication systems.

6. Work effectively in a group and demonstrate ability in comprehension, oral and written communication.

UNIT 1

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.

10 hours

UNIT 2

Communication medium**,** Parallel wire, twisted pair and coaxial cables, Waveguides, Optical fibers, Principles of wireless transmission, Microwave communication.

10 hours

UNIT3

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 De-multiplexing, FDM, TDM, PCM-TDM, Transmission of Digital data over analog channels, ASK, FSK, PSK, Types of Modems.

10 hours

References

1. **Louis E Frenzel: "***Principles of Electronic Communication systems*", 4th Edition, TMH, 2008.
2. **Wayne Tomasi: "***Electronic Communication Systems*", 5th Edition, Pearson education, 2007.

Subject Name & Code	**Simulation Lab – EC31L**
No. of Teaching Hours: 36	**Credits: 0:0:1.5 L-T-P**
CIE Marks : 50	**SEE Marks : -**

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

1. Perform basic mathematical operations, matrix algebra and plot graphs using a computational tool.

2. Analyze and validate DC/AC resistive circuits using a simulation tool.
3. Analyze and validate Transistor and Op-amp circuits using a simulation tool.
4. Analyze and validate Digital Circuits using a simulation tool.
5. Work effectively as a team member and come out with a conclusive interpretation of obtained outcomes.

List of Experiments

1. Basic Mathematic operations using GNU Octave.
2. Plots and Graphs using GNU Octave.
3. DC analysis of resistive networks using Tina TI tool.
4. AC analysis of resistive networks using Tina TI tool.
2. Basic Transistor Circuits (CE, CB, CC, amplification & Switching using Tina TI Tool.
3. Basic Transistor Circuits (CE, CB, CC, amplification & Switching using Tina TI Tool.
4. Basic Op-Amp Operations (Addition, Substation, Multiplication, Division) using Tina TI Tool.
5. Basic Digital Circuits simulation using Tina TI Tool (Combinational Circuits).
6. Basic Digital Circuits simulation using Tina TI Tool (Sequential Circuits).
7. Simulink for Circuit simulation.

Subject Name & Code	**Linear Integrated Circuits – EC410**
No. of Teaching Hours: 40 ; **Practical 12 Sessions.**	**Credits : 3:0:1 L-T-P**

CIE Marks : 50	SEE Marks: 50

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

1. Explain the operation and applications; perform analysis and design of Op- Amp ac and dc circuits.
2. Explain the operation and applications; perform analysis and design of Op- Amp linear circuits.
3. Explain the operation and applications and perform analysis of Signal conditioning and data converter circuits.
4. Explain the operation and applications; perform analysis and design of Op-Amp nonlinear circuits.
5. Perform analysis and design of Voltage regulators and explore the applications and realization of timing circuits.
6. Carry out a group task making use of simulation and analytical tools, document and give an effective presentation.

UNIT 1: 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

8 hours

UNIT 2: Op-Amp Linear Applications

Instrumentation amplifier, V to I and I to V converters, integrator and differentiator, Active filters.

8 hours

UNIT 3: 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.

8 hours

UNIT 4: Op-Amp Nonlinear Applications

Comparators, Schmitt trigger circuits, Square/Rectangular and Triangular wave generators, LOG and ALOG amplifiers.

8 hours

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). **8 hours**

References

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/

Linear Integrated Circuits Laboratory

LAB 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, sub tractor, Difference amplifier, Averager.
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.

Subject Name & Code	**Switching Systems & Access Networks - EC420**
No. of Teaching Hours: 50	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks: 50**

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

1. Demonstrate the working principles of switching networks, hierarchy in Network, ability to identify, formulate and solve problems considering stability, attenuation and losses.
2. Explain the hypothetical model of Digital Switching Systems and assess its impact through reliability analysis.
3. Develop mathematical model for switching system and carry out performance analysis.
4. Analyze digital switching system software, hardware architecture, network control and common channel signaling.
5. Solve numerical problems related to modeling and evaluate performance of switching systems.
6. Demonstrate the usage of software tools for simulation and analysis of Digital switching systems. Work in a group and prepare necessary documents for effective presentation by making use of ICT tools.

UNIT 1: Developments of telecommunications: Network structure, Network services, terminology, Regulation, Standards. Introduction to telecommunications transmission, Power levels, Four wire circuits, Digital transmission, FDM, TDM, PDH and SDH, Transmission performance.

10 hours

UNIT 2: Evolution of Switching Systems: Introduction, Message switching, Circuit switching, Functions of switching systems, Distribution systems.

Digital Switching Systems: Fundamentals, Purpose of analysis, Basic central office linkages, Switching system hierarchy, Evolution of digital switching systems, Stored program control switching systems, Digital switching system fundamentals, Building blocks of a digital switching system, PCM, digital transmission systems, Basic call processing.

10hours

UNIT 3: Telecommunications Traffic: Introduction, Unit of traffic, Congestion, Traffic measurement, Mathematical model, lost call systems, Queuing systems.

10hours

UNIT 4: Time Division Switching: Introduction, space and time switching, Time switching networks, Synchronization. Access networks: Local loop, ADSL, XDSL, WILL, Wi-Fi, Wi-Max, FTTH, HFC. Introduction to Stored program control switches.

10 hours

Unit 5: Switching System Software: Introduction, Scope, Basic software architecture, Operating systems, Database Management, Concept of generic program, Software architecture for level 1 control, Software architecture for level 2 control, Software architecture for level 3 control, Network and operational aspects and Common channel signaling.

10 hours

Self-learning components: Crossbar systems, ISDN, intelligent network.

References

1. **J E Flood:** "*Telecommunication and Switching, Traffic and Networks*", Pearson Education, Reprint 2002.
2. **Syed R. Ali**, "*Digital Switching Systems – Reliability and analysis*", Tata McGraw-Hill, 2002.
3. **John C Bellamy**: "*Digital Telephony*", 3rd Edition, Wiley India, 2000.
4. **F J Redmill and A R Valdar**: "*SPC digital telephone exchanges*", Peter Perigrinus Ltd IEEE telecom series 21, ISBN 0 86341 301 3, 1990.

E-Resource

1. E-books, e-learning: http://nptel.ac.in/courses/106105080/pdf/M4L1.pdf
2. Video lectures link: https://onlinecourses.nptel.ac.in/noc18_ee07

Subject Name & Code	Signals and Systems - EC430
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks : 50	SEE Marks: 50

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

1. Apply basic knowledge of science and mathematics to define and explain signals, Classify signals and perform basic operations on them, represent and analyze them in time-domain.
2. Define and explain systems, test them for their properties and represent and analyze LTI systems in the time domain using various methods.
3. Represent and analyze signals and systems in the frequency domain using Fourier series and Fourier transform techniques.
4. Represent and analyse discrete time signals and systems by applying z-transforms.
5. Demonstrate skill sets related to software tools in the analysis and simulation of signals and systems.
6. Apply proper reasoning and demonstrate written / oral communication skills in completing a group activity by adhering to ethical practices.

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.

08 Hours

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

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.

08 Hours

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

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.

07 Hours

UNIT 5: Z- transforms and Applications

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.

09 Hours

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

References

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*", 2nd Edition, PHI/Pearson Education, 2004.
3. **H P Hsu: "***Signals and systems***",** 2nd Edition, The McGraw Hill, 2008.

E-Resource

1. Video Lecture: https://nptel.ac.in/courses/1171040741.

Subject Name & Code	Digital System Design - EC440
No. of Teaching Hours: 40, Practical: 12 Sessions.	Credits : 3:0:1 L-T-P
CIE : 50	SEE Marks: 50

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

1. Demonstrate and apply the necessary concepts to perform arithmetic operations, numeric data representation and data transfer operation.
2. Formulate, analyze and design simple processing systems.
3. Analyze, design and implement control units.
4. Demonstrate the knowledge of microcomputer organization and design.
5. Demonstrate the skill sets related to the usage of EDA tool for analysis and simulation.
6. Work effectively as a member or as a leader in teams to complete tasks related to this course.

UNIT 1

Introduction: Inter Register Transfer Arithmetic. Logic and Shift Micro operations. Conditional control statement, Fixed point Binary Data, Overflow. Arithmetic Shift, Decimal data. Floating point data and Non numeric data. Instruction codes, Macro and Micro Operations.

8hours

UNIT 2

Design of a simple computing system: Processor logic Design; Introduction to processor organization, design of Arithmetic and logic units. Status Register, design of Shifters, Processor unit, design of Accumulator.

8 hours

UNIT 3

Control organization: one flip-flop per state method, PLA control and micro program control. Hardwired control, Micro program Sequencers.

8 hours

UNIT 4

Microcomputer system design: Microprocessor organization, Memory cycle, Instruction and addressing modes, Stack, subroutines and Interrupt.

8 hours

UNIT 5

I/O interface parallel peripheral Interface. Serial communication interface. DMA and DMA transfer in microcomputer system. **8 hours**

Reference:

1. **M Morris Mano:** "*Digital Logic and Computer Design*", Second Edition, Pearson Education, 2014.
2. **Carl Hamacher, ZvonkoVranesic, and SafwatZaky:** "*Computer Organization*", Fifth Edition, McGraw-Hill, 2002.
3. **Carl Hamacher, ZvonkoVranesic, and SafwatZaky**: "*Computer Organization*", Fifth Edition, McGraw-Hill, 2011 publication.

Digital System Design Laboratory

NOTE: The course outcomes given below are used to assess the overall ability and skill sets of the students in the labs. They are written in a generic manner. The exact competencies are with respect to the contents of the syllabus and are based on the nature of experimentation

List of Experiments (Programming using Verilog HDL)

Lab cycle 1: Combinational Circuits simulation using XILINX ISE

1. Write a HDL code to realize all the logic gates.
2. Write a HDL program for the following combinational circuits using all the three modeling styles.
    - Adders/ Subtractor (half adder/subtractor, full adder/subtractor).
    - Parallel adder, carry look adder.
    - 2 to 4 decoder.
    - 8 to 3 (encoder without priority & with priority).
    - 8 to 1 multiplexer.
    - 4 bit binary to gray converter, gray to binary.
    - Multiplexer, de-multiplexer.
    - Comparators.

Lab cycle 2: Sequential Circuits simulation using XILINX ISE

3. Develop the HDL Code for the following latches and flip-flops:
    - SR Latch, D Latch, JK Latch.
    - SR Flip-flop, JK Flip-flop, T flip-flop, D-flip-flop.

4. Develop an HDL Code for 4-bit binary, BCD up counter, down counter & up/down counter (Synchronous reset and asynchronous reset).
5. Develop an HDL code for a given 4-bit sequence: Any Sequence.
6. Develop an HDL code for Shift Registers (SISO, SIPO, PISO, PIPO, universal shift registers).
7. Write an HDL code for serial adder using state machines (Mealy & Moore model).

Lab cycle 3:

1. Design of the Arithmetic Logic Unit, Memory Unit and Control logic unit with the examples worked out in the theory classes.
2. Implementation of digital circuits using CPLD/FPGA.

Subject Name & Code	Engineering Electromagnetic - EC450
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks : 50	SEE Marks: 50

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

1. Describe various vector quantities and relate them to field quantities.
2. Formulate and analyze various EM problems for different charge distributions involving various boundary conditions.
3. Analyze and Compute Capacitance, Magnetic Force and Magnetic Field for different charge distributions involving various boundary conditions.
4. Derive and explain Maxwell's equations from first principles and apply them for time-varying cases.
5. Analyze EM wave propagation in different media, explain power flow and wave polarization.
6. Work in teams, to collectively recognize a problem, and to find workable solutions.

UNIT 1

Vector Analysis, Co-ordinate System, Coulomb's Law, Electric field intensity, Electric field due to various charge distribution, Electric flux and flux density, Flux density due to various charge distribution, Gauss Law, Applications of Gauss law, Divergence and Maxwell's Equations.

8 hours

UNIT 2

Work done & Line Integral Concept, Potential, Potential due to various charge distribution, Potential due to infinite line charge, Conservative field, Potential gradient ,dipole, Energy density in ES field, Current and current density, Equation of continuity, Conductor & dielectric, Boundary conditions, Concept of capacitance, Energy stored in capacitance.

8 hours

UNIT 3

Poisson's & Laplace Equations, Uniqueness Theorem, Calculating capacitance using Laplace's Equation ,Magnetic field & its properties, BiotSavart's Law, Computation of H using BSL, Ampere's Circuital Law, Computation of H using ASL, Curl & Stokes Theorem, Magnetic flux & flux density, Scalar & Vector Potentials, Magnetic forces, Boundary conditions for magnetic field.

8 hours

UNIT 4

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

8 hours

UNIT 5

Uniform plane waves, General equations, UPW in free space & various media, Poynting Theorem, Polarization of UPW.

8 hours

References

1. **William A Hayt, John A Buck,M Jaleel Akhtar:** "*Engineering Electromagnetics*", 8th edition , McGraw-Hill ,2014.
2. **Matthew N.O. Sadiku, S.V. Kulkarni:** "*Principles of Electromagnetics*", 6th edition, Pearson Eduction, 3rd Impression, 2016.
3. **Karl E. Lonngren, Sava V. Savov:** "*Fundamentals of Electromagnetics with MATLAB*", 2nd edition, SciTech Publications, 2007.

E-Resource

1. Video Lecture: http://nptel.ac.in/courses/108106073.

Subject Name & Code	Data Structures and Algorithms - EC460
No. of Teaching Hours: 40	Credits : 3:0:0 L-T-P
CIE Marks : 50	SEE Marks: 50

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

1. Demonstrate programming skills through Object Oriented Programming Concepts to implement different data structures and related algorithms.
2. Identify and evaluate appropriate data structure and algorithm as applied to specified problem definition.
3. Develop applications using data structures and algorithms.
4. Develop innovative programming solutions/ modify available solutions by improving the existing code.
5. Evaluate algorithms and data structures in terms of time complexity, space complexity and asymptotic analysis.
6. Complete a group task, demonstrate abilities in oral/ written communication and in collaborative learning.

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.

08 Hours

UNIT 2

Arrays and Matrices, Single Linked List, Double Linked List, Circular Linked List, Stacks, Linear Queues, Circular Queues.

08 Hours

UNIT 3

Types of Trees, Binary Tree and its representation, Types of Binary Tree, Tree Traversal, Binary Search Tree, Balanced Binary Search Tree (AVL), Heaps, Disjoint Sets (Union and find algorithm).

08 Hours

UNIT 4

Terminologies Used, Representation and Implementation of a Graph, Operations on Graph, Graph Traversal, Breadth First Search, Depth First Search and Topological Sort, Application of Graphs for Strongly Connected Components and Dijkstra's Algorithm. **08 Hours**

UNIT 5

Space and Time Complexity, Asymptotic Notation, Recursion, Sorting Techniques, Search Techniques, Skip List, Hashing.

08 Hours

Self-learning components: ALGORITHM DESIGN TECHNIQUES: Greedy algorithm (Minimum Spanning Tree), Divide and Conquer (Merge Sort), Dynamic Programming (Shortest Path Problem), backtracking.

References

1. **SartajSahni,** "*Data Structures, Algorithms and Applications in C++*", McGraw Hill Education, 2000.
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.

E-Resource

1. Video Lecture: https://nptel.ac.in/courses/106102064/

Subject Name & Code	Analog Communication- EC510
No. of Teaching Hours: 40; Practical: 12 Sessions	Credits: 3:0:1 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Explain the different types of noise exist in communication systems and power measurement units.
2. Describe the operations of PLL, Frequency synthesizers and phase discriminators circuits.
3. Explain the operation of the AM modulation and detection.
4. Explain the working principle of the DSBSC and SSBSC modulation and detection.
5. Describe the fundamental concepts of narrow-band and wide-band FM generation and detection.
6. Work as a member or a leader in teams to implement assigned tasks related to advanced topics.

UNIT 1: Introduction to electronic communication systems

Introduction to electronic communication systems, Power measurement units, EM frequency spectrum, Bandwidth and information capacity, Noise analysis, Signal analysis and mixing, power spectra.

8hours

UNIT 2: Phase lock loops and Frequency Synthesizers

Phase lock loops. PLL capture and lock ranges, PLL loop gain, Phase comparators, frequency synthesizers and Digital PLL.

8hours

UNIT 3: **AM transmission and Reception**

Introduction, principles of Amplitude modulation, AM modulating circuits, AM Transmitters, AM receivers, AM receiver circuits, QAM.

8hours

UNIT 4: Single sideband communication systems

SSB Generation, SSB transmitters, Mathematical analysis of Suppressed carrier systems, SSB reception. Single side band and suppressed carrier and FDM and SSB measurements.

8hours

UNIT 5: **Angle Modulation Transmission and reception**

Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave - Generation of FM Waves, Direct FM, Detection of FM Waves: Balanced Frequency discriminator, Zero crossing detector.

8hours

SLE: TV transmitter and receivers , FM stereo broadcasting.

References

1. **Wayne Tomasi** : "*Electronic Communication Systems***",** 5th edition, Pearson Education,
2. **B P Lathi and Zni Ding:** "*Modern analog and Digital communication Systems*", 4th Edition.2017.
3. **Simon Haykins:** "*Communication Systems***"**, 5th Edition, John Wiley, 2009
4. **Michael Fitz:** "*Fundamentals of Communication Systems***"**, TMH, 2008 (for MATLAB exercises and mini projects).

E-Resource

1. EBook: https://ebook.naukriassam.com/bp-lathi-modern-digital-anal
2. https://archive.org/.../BookModernDigitalAndAnalogComm.

Analog Communication Laboratory

List of experiments

1. To demonstrate the working of pulse amplitude modulation & demodulation circuit.
2. To demonstrate the working of pulse width modulation& demodulation circuit using IC-555 timers.
3. To demonstrate the working of pulse position modulation circuit.
4. To demonstrate the working of an amplitude modulation & demodulation circuit and to calculate Modulation index of AM.
5. To demonstrate the working of DSB-SC Modulation & Demodulation using IC 1496.
6. To demonstrate the working of SSB-SC Modulation & Demodulation circuits.
7. To demonstrate the working of Frequency Modulation using IC 8038 & Demodulation circuits.

8. To demonstrate the working of working of PLL.
9. To demonstrate the working of Frequency Synthesizer using IC 565.
10. To demonstrate the working of a working of PLL as a frequency doublers circuit.

Subject Name & Code	**Microcontrollers & Applications – EC520**
No. of Teaching Hours: 40, **Practical: 12 Sessions.**	**Credits : 3:0:1 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Apply knowledge of engineering fundamentals to demonstrate an understanding of the architecture of 8051 Microcontroller.
2. Demonstrate the understanding of instruction set of 8051 and develop programming skills by applying logical reasoning.
3. Demonstrate the programming skills based on hardware features available within 8051 microcontroller for different applications.
4. Design and develop programs related to applications using interfaces.
5. Apply knowledge of engineering fundamentals to demonstrate an understanding of the architecture & programming of ARM Microcontroller.
6. Engage in self-study and work in a team to explore technological advancements.

UNIT 1

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

08Hours

UNIT 2

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.

08Hours

UNIT 3

Timer/counter, serial communication and interrupt programming:-Programming 8051 timer/counter, basics of serial communication, 8051 connection to RS 232, 8051 serial port programming, 8051 interrupts, programming timer interrupts, programming external hardware interrupts, programming serial communication interrupts.

08Hours

UNIT 4

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

UNIT 5

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

SLE component: Study architecture o and programming of ARM 7 microcontroller.

References

1. **Kenneth J Ayala:** "*The 8051 Microcontroller Architecture, Programming and Application* " **-** 2 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 Wrigh: "***ARM system developer Guide Designing and Optimizing System Software*" Elsevier 2004.

E-Resource

1. **http://infocenter.arm.com/help/topic/com.arm.doc**
2. **http://www.keil.com**
3. **https://swayam.gov.in/**

LAB 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.

Subject Name & Code	Control Systems – EC530
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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.

08 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.

08 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. **10 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. **10 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:

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

Subject Name & Code	Digital Signal Processing – EC540
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits: 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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.

08 Hours

UNIT 2:

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

08 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.

08 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.

08 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.

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

Subject Name & Code	**Operating Systems – EC550**
No. of Teaching Hours: 40, **Tutorials: 12 Sessions.**	**Credits: 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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.

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 Computer 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, Semaphores, Firewalls, establishing inter-process communication.

08 Hours

Self-learning components: Case studies related to different operating system functions.

References

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

E-Resource

1. **EBook:**
   http://www.uobabylon.edu.iq/download/M.S20132014/Operating_System_Concepts,_8th_Edition[A4]
2. **Video lecture:** https://onlinecourses.nptel.ac.in/noc17_cs29/student/home.

Subject Name & Code	Linear Algebra & Applications – EC560
No. of Teaching Hours: 52	Credits : 4:0:0 L-T-P
CIE marks: 50	SEE Marks: 50

Course Outcomes: 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 an 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, Least Square Problems, application of Linear Models and inner product spaces. **10 Hours**

Self-learning component: Applications of linear algebra: Singular value Decomposition, Correlation, FFT and Convolution using Matrix, Diagonalization of convolution and matrix, Application of LDA, PCA (dimensionality reduction), and SVM.

References:

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

Subject Name & Code	**DSP Lab – EC51L**
No. of Teaching Hours: 36	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	**SEE Marks: -**

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

1. Verify basic concepts of signal processing in time and frequency domain.
2. Design, test and simulate FIR and IIR filters.
3. Design, test and simulate adaptive filters.
4. Verify the concepts of Multi rate DSP.
5. Verify the DSP concepts in real time using a Processor.

List of Experiments

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. 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.

3. 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.
4. 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.
5. 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.
6. 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).
7. 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.
    a. Write a MATLAB code to verify the Low pass Butterworth IIR filter design using bilinear transformation (BLT) method and Impulse Invariant Technique (IIT) method.
    b. 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.
8. 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.

a. 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.

9. 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.

Hardware Experiment Using TMS320C6713 DSP Kit

10. Write a C code to obtain the impulse response of a given system and implement the same on TMS320C6713 DSK kit.
    a. Write a C code to compute the linear and circular convolution and implement the same on TMS320C6713 DSK kit.
11. Write a C code to compute the cross correlation and auto correlation and implement the same on TMS320C6713 DSK kit.
12. Write a C code to compute N-point DFT and IDFT of a sequence and implement the same on TMS320C6713 DSK kit.

References

1. Proakis, Manolokis, Vinay Ingle, ***Digital Signal Processing***, Pearson India, 4th Ed, 2007.
2. Robert A. Schilling, Sandra L. Harris, ***Introduction to Digital Signal Processing using MATLAB***, 2013.
3. Rulph Chassaing, Donald Reay, ***Digital Signal Processing and Applications with C6713 and C6416 DSK***, Wiley 2nd Edition, 2008.

Subject Name & Code	Digital Communication – EC610
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Identify and analyze the importance of the functions of different components of a digital communication system and apply various coding techniques used in information theory and coding.
2. Explain and analyze the working of digital communication 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: Elements of Digital communication and information theory

Model of a digital communication system ; logarithmic measure of information, entropy and information rate, conditional entropy and redundancy, source coding fixed and variable length code words, Source coding theorem, prefix doing and craft inequality, Shannon – Fano and Huffman coding for 1^{st} , 2^{nd} and 3^{rd} order extensions, maximum entropy of a continuous source(with Gaussian distribution) entropy of a band limited white Gaussian noise, Mutual information and channel capacity of a discrete memory less channel, of a BSC, Hartley Shannon law

08 hours

Unit 2: 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.

Digital multiplexing: Fundamentals of time division multiplexing, electronic commutator, bit, byte interleaving E1 Carrier system, Synchronization and signaling of E1, TDM, PCM hierarchy.

PDH and SDH systems. 08 **hours**

Unit 3: 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.

08 Hours

Unit 4: Digital modulation techniques:

Types of digital modulation, wave forms for amplitude, frequency and phase shift keying. Method of generation and detect ion of coherent & non – coherent binary ASK, FSK & PSK, differential phase shift keying, Quadrature modulation techniques (QPSK and MSK) probability of error and comparison of various digital modulation techniques.

08 Hours

Unit 5: Error control coding:

Hamming distance and hamming bound, relation between minimum distance and error detecting and correcting capability, linear block codes, encoding & syndrome decoding; cyclic codes, encoders and decoders for systematic cycle codes; convolutional codes.

08 Hours

Self learning Component: OFDM and its importance, applications, Spread spectrum communication and CDMA, Recent developments in Digital Communication systems

References

1. **T. L Singal:** "*Digital Communication*" McGraw Hill Publication 2017.
2. **K. Sam Shanmugam**: "*Digital and Analog communication Systems*", Wiley India edition. 2015.
3. **Simon Haykin**: "*Digital Communication*", Wiley India edition. 2015.

E-Resource

1. Video Lecture: http://nptel.ac.in/courses/117101051/

Subject Name & Code	**Computer Networks – EC620**
No. of Teaching Hours: 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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

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.

08 Hours

Unit 2: Media Access Control

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.

08 Hours

Unit 3: Wireless LAN & IP Addressing

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. **08 Hours**

Unit 4: Network Layer

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).

08 Hours

Unit 5: Transport Layer

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

References

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/

Subject Name & Code	CMOS VLSI CIRCUITS– EC630
No. of Teaching Hours: 40; Practical: 12 sessions.	Credits : 3:0:1 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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.

Subject Name & Code	Optical fiber communication – EC640
No. of Teaching Hours: 52	Credits : 4:0:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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. . **12 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

Subject Name & Code	**Advanced Communication Lab – EC61L**
No. of Teaching Hours: 36	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	**SEE Marks: -**

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

1. Design and demonstrate the working of LPF & HPF m-derived filters
2. Explain and demonstrate the working of few digital MODEMS (ASK, FSK & BPSK) using discrete components and Kits
3. Set up and demonstrate the working of microwave bench set to characterize few antennas plot their radiation patterns and infer properly.
4. Work in groups and as an individual to gain practical communication knowledge and do innovation.
5. Do simulations of few digital modulations like PCM, DM and QPSK using MATLAB tools. Properly document the results and conclude about the results.

List of Experiments

1. M-derived Low Pass Filter (T & π type)
2. M-derived High Pass Filter (T & π 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(Using Discrete and Kit)
9. Microwave antenna experiments
10. Simulation experiments using MATLAB/SIMULINK

a. Butterworth & m derived filters- Compare practical & simulated results
b. Digital modulations: ASK, FSK, BPSK, DPSK, MSK & QPSK- Compare practical & simulated results.
c. PCM & Adaptive Delta modulation.

11. Experiments on FOC, SDR & IOT.

References

1. **Simon Haykin**: "Digital Communication", Wiley India edition. 2015.

Subject Name & Code	**Design & Implementation Lab – EC62L**
No. of Teaching Hours: 36	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	**SEE Marks: -**

In this course students are advised to conduct an extensive literature survey, to select an idea or conceptualize a functional block, design and implement the same test /analyses the design for its functionality, and prepare a report as well as an article, and give a demonstration.

Course Objectives

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

Course outcome: During the course period, the student must be able to

1. Conduct literature survey, listing out the objectives and synopsis preparation
2. Develop a Mathematical model and design the required circuit
3. Demonstrate various modern tools usage, to carry out the chosen work
4. Perform demo as per specifications, and meeting the objectives: Report writing (consolidated) & Article writing (keeping target audience in mind)
5. To demonstrate skills related to group activity adhering to standard ethics

General Guidelines for conducting Design and Implementation Lab:

1. Generate the Ideas according to market/societal needs, the idea to implementable within 4-months.
2. Refine the ideas suitably, Create methodology, to materialize the ideas.
3. Design the complete circuit model
4. Develop functional blocks and to test them (functionality test)
5. Build prototype by integrating the sub blocks
6. Testing the functionality of the prototype(Testing)
7. Perform analysis of the circuit (Performance analysis)

NOTE

1. To promote group activity
2. Group to accommodate minimum of 3 and maximum of 4 persons
3. Group to generate project idea giving importance to its practicability
4. **Project can fall into any broad areas viz. Analog-Digital electronics/Digital signal processing/Microcontrollers and embedded systems/communication and networking etc. Sensors and controls etc.**

Department Electives – VI Semester

	GROUP A (3:1:0)		GROUP B (3:1:0)
EC651	Advanced Digital Signal Processing	EC661	Electronic System Design
EC652	Digital Image Processing	EC662	Multimedia Communication
EC 653	Robotics and Computer Vision	EC663	JAVA Programming
EC654	Renewable Energy Systems	EC664	MEMS
EC655	Artificial Neural Networks	EC665	Wireless Networks

EC656	**Modeling and Simulation of communication system.**	**EC666**	**Computational Machine learning using Julia**

Subject Name & Code	Advanced Digital Signal Processing – EC651
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Explain the concepts of random signals and system response.
2. Illustrate the modeling of random signals as output of digital filters and validate.
3. Estimate power spectrum of a random signal from a realization.
4. Demonstrate and implement adaptive filters and algorithms
5. Analyze multirate signal processing algorithms in both time and frequency domain
6. Verify the advanced signal processing concepts by simulating using modern tools.

UNIT 1

DSP overview: Discrete time signals and systems, structures of DT systems, convolution, correlation, DFT, radix-2 FFT algorithms, FIR and IIR filters, Random Variables, Random processing, Probability density function and Cumulative distributive function, Ensemble average, Stationary process, ergodicity.

08 Hours

UNIT 2

Parametric Signal modeling, Least squares method, Pade Approximation, Prony's method, Pole-zero modeling, All pole modeling, Linear Prediction, Properties of LP filters, Lattice filters, AR and ARMA processes and models, Moving Average Models, Levinson-Durbin Algorithm, Properties.

08 Hours

UNIT 3

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 4

Introduction to Adaptive filters, applications of adaptive filters, Gradient descent algorithm, LMS, Normalized LMS and RLS algorithms, Convergence issues, Weiner filter and Kalman filters.

08 Hours

UNIT 5

Introduction to Multirate DSP, Decimation, Interpolation, Frequency domain interpretation, Sampling rate conversion, Applications of Multirate signal processing, Wavelet filter bank.

08 Hours

SLE Component: Study of classic paper by H. Akaike, *A New Look at the Statistical Model Identification*, IEEE Transaction on Automatic Control, Vol 19(6), 1974.

References

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. Vaidyanathan**, "*Multirate Systems and Filter Banks"*, Pearson Education, 2006.
4. **Shalini Apte**, *"Advanced Digital Signal Processing"*, Wiley India Ltd, 2013.

E-Resource

1. **Video Lecture:** https://nptel.ac.in/courses/108108109

Subject Name & Code	**Digital Image Processing – EC652**
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Demonstrate the knowledge on Digital image fundamentals and Image enhancement techniques in spatial and frequency domain.
2. Apply basic morphological algorithms for digital image processing.
3. Explain the various color models and basic segmentation techniques.
4. Demonstrate the applications of basic image compression techniques.
5. Work as a team member and 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

SLE Component: Recent trends and Case studies: Pattern recognition problems from recent journal publications.

References

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/

Subject Name & Code	Robotics & Computer Vision – EC653
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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. Apply the Kinematics concepts required to manipulate and control the links and joints.
4. Develop 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 Problem Solving

Time & motion Trajectories: 1-dimensional, multi-dimensional, multi-segment, Interpolation of rotation, Smooth Cartesian motion, Time-varying coordinate frames, angular velocity, Inertial navigation solution, Problem Solving

08 hours

UNIT 2:

Mobile Robot Vehicles: Mobility, Bicycle and Car like models, moving to a point, line & pose, Modeling of Quadcopter (Flying robots), Demo by simulation

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, Demo by simulation

08 hours

UNIT 3:

Kinematics: Forward kinematics, Inverse kinematics, Trajectories Assigning Denavit-Hartenberg parameters, Applications, Problem solving

Velocity relationships Manipulator Jacobians, Resolve-rate motion control Force relationships, under and over actuated manipulators, Problem solving

Dynamics & Control: Independent Joint control, Rigid body equations of motion: gravity, inertia, Coriolis Forward dynamics, rigid body dynamics compensation, Problem solving

08 hours

Unit 4

Computer Vision Fundamentals: Light & color Spectral representation of light Color, color spaces, color gamut, color consistency, White balance Gamma correction,

Camera model: Image formation Perspective imaging,

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

08 hours

Unit 5

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

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

SLE Component: 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.

References:

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/

Subject Name & Code	**Renewable Energy Systems – EC654**
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Acquire a knowledge on conventional and non-conventional energy resources and its comparison.
2. Describe solar-earth geometry and estimate solar radiation falling on a flat and tilted surface.
3. Describe solar thermal, and PV systems.
4. Describe different energy storage technologies.
5. Describe wind and biomass energy systems and methods of harnessing energy from ocean.
6. Work in groups, communicate effectively and document outcomes related to recent trends and techniques.

UNIT 1: Energy Sources

Introduction. Importance of energy consumption as a measure of prosperity. Per Capita Energy Consumption. Classification of Energy Resources. Conventional Energy Resources — availability and their limitations; Non-Conventional Energy Resources — classification, advantages, limitations. Comparison of conventional and non-conventional energy resources. World Energy Scenario. Indian Energy Scenario.

08 Hours

UNIT 2: Solar Energy Basics

Introduction. Solar Constant. Basic Sun-Earth Angles – definitions and their representation.

Solar Radiation Geometry (numerical examples). Estimation of solar radiation of horizontal and tilted surfaces (numerical examples). Measurement of solar radiation data – pyranometer and pyrheliometer.

Solar Thermal Systems

Principle of conversion of solar radiation into heat. Solar water heaters (flat plate collectors),

Solar cookers — box type, concentrating dish type, solar driers, solar still, solar furnaces, solar green houses.

08 Hours

UNIT 3: Solar Electric Systems

Solar thermal electric power generation – solar pond and concentrating solar collector (parabolic trough, parabolic dish, central tower collector), advantages and disadvantages. Solar photovoltaic – solar cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems – stand-alone and grid connected. Applications -– street lighting, domestic lighting and solar water pumping systems.

08 Hours

UNIT 4: Energy Storage

Introduction, necessity of energy storage, and methods of energy storage (classification and brief description using block diagram representation only). Types of batteries currently available for renewable energy storage applications. Energy conversion options-converters and inverters. Battery storage options for meeting peak load applications. Selection and sizing of batteries — basic procedure.

Wind Energy: Introduction. Wind and its properties. History of wind energy. Wind energy scenario – world and India. Basic principles of Wind Energy Conversion Systems (WECS), Classification of

WECS, Parts of a WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS, Wind site selection consideration, Advantages and Disadvantages of WECS.

08 Hours

UNIT 5: Biomass Energy

Introduction. Energy by photosynthesis process. Biomass fuels classification — cultivated biomass, waste organic matter. Biomass conversion technologies — direct, thermochemical, and biochemical. Urban waste to energy conversion—waste composition, conversion by incineration process, conversion by pyrolysis, landfill biogas plant, utilisation of wood/timber waste in fluidized bed combustion boilers. Biomass gasification. Biomass to ethanol production. Biogas production from waste biomass. Factors affecting biogas generation.

Energy from Ocean: Tidal energy – principle of tidal power. Components of tidal power plant (TPP). Classification of tidal power plants. Estimation of energy – single basin and double basin type tidal power plants (no derivations. Simple numerical problems). Advantages and limitation of tidal power plants. Tidal

power potential in India and pilot plants. Ocean Thermal Energy Conversion (OTEC) – principle of OTEC system, methods of OTEC power generation -– Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC). Site selection criteria, advantages and limitation of OTEC.

08 Hours

References

1. **Rai G. D**: "Non-conventional Sources of Energy", 4th Edition, Khanna Publishers, New Delhi, 2007.
2. **Khan, B. H**: "Non-conventional Energy Resources", TMH, New Delhi, 2006.
3. **Mukherjee, D**: and Chakrabarti, S., "Fundamentals of Renewable Energy Systems", New Age International Publishers, 2005.
4. **S. Rao and Dr. B. B. Parulekar**: "Energy Technology – Nonconventional, Renewable and Conventional", 3rd Edition, Khanna Publishers, New Delhi.

E-Resource

1. Video Lecture: http://nptel.iitm.ac.in/index.php.

Subject Name & Code	Artificial Neural Networks – EC655
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Demonstrate the fundamental theory and concepts of neural networks, network architectures, learning methods, several neural network paradigms and its applications.
2. Demonstrate hands on experience on the selected state of the art applications of Neural Networks
3. Comprehend on various neural network algorithms.
4. Work as a team member and demonstrate critical thinking by exploring and implementing various Artificial Neural Network algorithms.

UNIT1: Introduction and ANN Structure

Biological neurons and Structure of biological neurons relevant to ANNs, Model of an ANN, Benefits and applications of the artificial neural networks, Activation functions used in ANNs, Models of network architecture. (Feedforward and feedback networks), Learning Methods: Supervised, Unsupervised and Competitive learning

08 Hours

UNIT2: Single layer perceptron's and Feedforward ANN

Structure and learning of perceptron's, Pattern classifier - introduction and Bayes 'classifiers, Perceptron as a pattern classifier, Perceptron convergence, Limitations of a perceptron's, Structures of Multi-layer feedforward networks, Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation, Practical and design issues of back propagation learning.

08 Hours

UNIT3: Single layer feedback Networks, Radial Basis Function Networks and SVM

Basic Concepts, Hopfield networks, Pattern separability and interpolation, Regularization Theory, Regularization and RBF networks, RBF network design and training, Approximation properties of RBF, Linear separability and optimal hyperplane, Determination of optimal hyperplane, Optimal hyperplane for non-separable patterns, Design of an SVM

08 Hours

UNIT4: Recurrent Neural Networks, Fuzzy Neural Networks, Associative Learning and Competitive Learning

Introduction to RNNs, Neuro-fuzzy systems, Background of fuzzy sets and logic, Design of fuzzy ANNs, Associative models, Boltzmann Machine, General clustering procedures, Learning Vector Quantization (LVQ), Components of a competitive Learning Network, Competitive learning algorithms and architecture.

08 Hours

UNIT5: Recent Applications of ANNs

Object Recognition Using Neural Networks, Face Recognition Using Neural Networks, Face Detection Using Neural Networks, Fingerprint Recognition Using Neural Networks, Handwriting Recognition Using Neural Networks

08 hours

References

1. **Simon Haykin**, "*Neural Networks: A comprehensive foundation*", Second Edition, Pearson Education Asia.
2. **Satish Kumar**, "*Neural Networks: A classroom approach*", Tata McGraw-Hill, 2004.
3. **Robert J. Schalkoff**, "*Artificial Neural Networks*", McGraw-Hill International Editions, 1997.
4. **B. Yagnanarayana**, "*Artificial Neural Networks*", PHI Learning, 2009.

Subject Name & Code	**Modeling and Simulation of communication systems–EC656**
No. of Teaching Hours: 40, **Tutorials: 12 Sessions.**	**Credits : 3:1:0 L-T-P**

CIE Marks: 50	SEE Marks: 50

In this course students are advised to do mathematical modelling of communication systems, and study their behavior through simulation using modern tools (MATLAB/ SCILAB/OCTAVE)

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

1. Develop mathematical models using advanced mathematical concepts
2. Implement the models using standard tools
3. Test and analyse the models, document, tabulate and compare results
4. Demonstrate skills related to tool usage and result interpretation,
5. Realise mathematical models as circuit level simulations
6. Work in groups demonstrating team sprits, adhering to standard ethical practices

(NOTE: MATLAB / OCTAVE / SCILAB/TINA can used as tools)

UNIT 1

Introduction to Systems, Models and simulations: Systems simulation, modeling and simulation, simulation types.

Introduction to simulation environment, writing codes, executing and ploting various 2D, 3D graphs, simulation of signals and systems (Filters and Transfer functions).

Note: Exercises are to be given to write codes

08 Hours

UNIT 2

Simulation of analog modulation systems: Amplitude modulation systems, variants of AM DSBSC and SSB systems, Demodulation and Noise performance.

Simulation of Angle Modulation Systems: Frequency and Phase modulation systems, bandwidth noise in FM.

Note: Exercises are to be given to write codes

08 Hours

UNIT 3

Simulation of Digital modulation systems: Quadrature signals digital modulation of a carrier wave ASK, FSK, PSK, DPSK, MPSK, MSK,GMSK eye diagrams , probability of bit error and pulse modulation schemes(PCM ,PPM, dpcm DM ADM).

Note: Exercises are to be given to write codes

08 Hours

UNIT 4

Fundamentals of Random Variables and Random Processes for Simulation, Monte Carlo Simulation and Generation of Random Numbers

Wired and wireless Communication Channels modeling and simulation

Estimation of Parameters in Simulation, Estimation of Performance Measures from Simulation.

Note: Exercises are to be given to write codes

08 Hours

UNIT 5

Case Studies: build higher level communication systems, using sub-modules conduct performance analysis (class seminar & PPT presentation/self-study component).

Note: Exercises covering higher level system simulation are to be given to write codes

08 **Hours**

References

1. **Jeruchim, Michel C., Balaban, Philip, Shanmugan, K. Sam**: "*Simulation of Communication Systems: Modeling, Methodology and Techniques*", Springer, 2000.
2. **Banks, J. and Carson, J. S**., "*Discrete Event System Simulation*", Prentice Hall, 2009.
3. **Averill, M. L., and Kelton, W.D**, "*Simulation Modeling and Analysis*", McGraw Hill, 2006.
4. **K.C.Raveendranathan**, "*Communication Systems Modelling and Simulation*", Universities press, 2011.

Subject Name & Code	Electronic System Design – EC661
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Outline the development process for electronic systems with standard drawings and computer technology.
2. Expound the system-level functions and structures, design variants, and various technological implementations for a design solution.
3. Demonstrate the need for reliability analysis and explain the primary reliability parameters.
4. Analyse the different materials used for thermal management and EMC compatibility, and evaluate them for electronic system design
5. Signify the importance of circular economy and explicate the concepts of product recycling and material recycling.
6. Work efficiently in a group and complete the assigned task by demonstrating skills related to documentation and oral communication.

UNIT 1:

Design Process and Its Fundamentals: Life Cycle of Electronic Products, Design and Development Process, Guidance for Product Planning, Design and Development, Technical Drawings, Circuit Diagrams.

08 Hours

UNIT 2:

System Architecture and Protection Requirements: Introduction—Terminology, Functions and Structures, System Characteristics of Devices, System Environment, System Functions, System Structure, System Design Architecture, System Granularity, System Assembly, System Integration in Environment, Electronic System Levels, System Protection, CE Designation, Protection Classes, IP Codes of Enclosures.

08 Hours

UNIT 3:

Reliability Analysis: Introduction, Calculation Principles, Failure of Electronic Components, Failure of Electronic Systems, Reliability Analysis of Electronic Systems, Recommendations for Improving Reliability of Electronic Systems.

08 Hours

UNIT 4:

Thermal Management and Cooling: Introduction—Terminology, Temperatures, and Power Dissipation, Calculation Principles, Application Examples in Electronic Systems, Recommendations for Thermal Management of Electronic
Systems.

Electromagnetic Compatibility (EMC): Coupling Between System Components, Grounding Electronic Systems, Shielding from Fields, Electrostatic Discharge (ESD), Recommendations for EMC-Compliant Systems Design.

08 Hours

UNIT 5:

Recycling Requirements and Design for Environmental Compliance: Introduction—Motivation and the Circular Economy, Manufacture, Use, and Disposal of Electronic Systems in the Circular Economy, Product Recycling in the Disposal Process, Material Recycling in the Disposal Process, Design and Development for Disassembly, Material Suitability in Design and Development, Recommendations for Environmentally Compliant Systems.

08 Hours

References:

1. **Lienig, Jens, Bruemmer, Hans,** "*Fundamentals of Electronic Systems Design*", Springer, 2017.
2. **Bernhard E. Bürdek**, "*History, Theory and Practice of Product Design*", Springer Science, 2005
3. **Paul Horowitz**, "*Art of Electronics*", Cambridge University Press.
4. **Jerry C Whitaker**, "*The Electronics Handbook*", CRC Press, IEEE Press.

Subject Name & Code	Multimedia Communication – EC662
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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:

T**ext 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

References

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.

Subject Name & Code	JAVA Programming – EC663
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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.

10 hours

UNIT 4

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

06 hours

Unit 5

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

06 hours

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

References:

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

NPTEL Course: http://nptel.ac.in/courses/106106147/3

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

Subject Name & Code	MEMS – EC664
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Acquire knowledge on the fundamentals of MEMS and Microsystems.
2. Qualitative analyze on the design considerations of Microsystems.
3. Apply scaling laws to rigid body dynamics, electrostatic/electromagnetic forces, fluid mechanics and heat transfer.
4. Identify and select different materials for MEMS and Microsystem devices/components.
5. Comprehend on advanced fabrication process of MEMS and Microsystem.
6. Work effectively as a member/leader in teams to complete the assigned tasks.

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.

SLE: 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.

SLE: 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.

SLE: 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.

SLE: Packaging materials

08 hours

UNIT 5: Overview of Microsystems Fabrication Process and Micromanufacturing

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.

SLE: NEMS devices

08 hours

References

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, Cpyright 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

Subject Name & Code	Wireless Networks - EC665
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Explain the working and architecture of wireless technologies.
2. Analyze the challenges and design issues of mobile network layer.
3. Analyze the challenges and design issues of mobile transport layer.
4. Demonstrate the knowledge on wireless wide area network architecture.
5. Acquire the knowledge on fundamentals of advanced generations of Communication system.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

UNIT 1: Wireless LAN

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security – IEEE802.16-WIMAX: Physical layer, MAC, Spectrum Allocation for WIMAX.

08 hours

UNIT 2: Mobile Network Layer

Introduction – Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet-Mobile IP session initiation protocol – mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

08 hours

UNIT 3: Mobile Transport Layer

TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility – Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP – TCP over 3G wireless networks**.**

08 hours

UNIT 4: Wireless Wide Area Network

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3GMSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed

Downlink packet access (HSDPA) - LTE network architecture and protocol.

08 hours

UNIT 5: 4G/5G Networks

Introduction – 4G vision – 4G features and challenges – Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna Techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

08 hours

Self-Learning Components: Cognitive Radio. Software Defined Radio

References

1. **Jochen Schiller:**"*Mobile Communications*", Second Edition, Pearson Education 2013. (Unit I, II, III)
2. **Vijay Garg**: "Wireless Communications and networking", First Edition, Elsevier 2007. (Unit IV, V).
3. EBook: **William stalling**: "Wireless Communications and Networking", second edition, Pearson Education, 2005.

E-Resource

1. Video Lecture: http://nptel.ac.in/courses/106105081/23

Subject Name & Code	Computational Machine Learning using Julia - EC666
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

Course Objectives

The objectives of the Course:

1. Learn machine learning, deep learning and AI concepts.
2. Provide hands-on training so that students can write applications in AI.
3. Provide ability to run real machine learning production examples.
4. Understand programming techniques that underlie the production software.

Topics:

- Representing Data with Models. Use of functions and parametric functions to build models.
- Model Complexity, what is learning from a Computational point of view. How does a Computer learn?
- Exploring Data with Unsupervised Learning, Dimensionality reduction for Image Classification.
- Applications using Unsupervised Machine learning
- Introduction to Supervised Machine Learning
- Practical Applications using Supervised Machine Learning, (Object detection etc.)
- Introduction to Neurons, Learning with a Single Neuron
- Introduction to Flux.jl, learning with a single neuron using Flux
- Introduction to Neural Networks, Building single layer neural net with Flux
- Introduction to Deep Learning, Multi-Layer Neural Network with Flux
- Handwritten recognition with neural networks

Learning Outcomes:

1. Students will able to learn machine learning and the underlying algorithms.
2. Participants can consider themselves not as consumers of APIs of various ML libraries, but can become comfortable with building the underlying algorithms in Julia and be able to contribute to various ML packages and in general to Julia.

References

1. **Christopher M Bishop**: “Pattern Recognition and Machine Learning” 1st Edition, Springer, 2006 (PDF available on web).
2. **Avik Sengupta**: “Julia High Performance” 1st Edition, Packt Publication Ltd, 2016.
3. **Anshul Joshi, Rahul Lakhanpal**: “Learning Julia”, 1st Edition, Packt Publication Ltd, 2017.

Ivo Balbaert, Avik sengupta, Malcolm Sherrington: “Julia: High Performance Programming”, 1st Edition, Packt Publication Ltd, 2016.

Subject Name & Code	**Microwave and Antennas - EC710**
No. of Teaching Hours: 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Distinguish different bands in microwave frequency range, their applications, explain hazards of radiation and demonstrate the problem solving ability.
2. Explain the fundamental feature of Strip lines and the concepts of Microwave Integrated Circuit design (MIC).
3. Demonstrate the knowledge on importance of radiometry, Television standards and HDTV.
4. Outline the basic concepts of Radar systems, explain the different types of radars and demonstrate the problem solving ability.
5. Illustrate the principles of basic types of antennas; quantify the specifications and their applications.
6. Work in groups, communicate effectively and document outcomes related to recent trends and techniques using simulation tools and ICT

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

Subject Name & Code	Mobile Communication- EC720
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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, GSM network interfaces, protocols and CDMA channel concepts
4. Comprehend and explain various techniques of data communication over cellular channels.
5. Comprehend and explain various modulation techniques, error detection and coding, path loss models and solutions.
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.

SLE: 5G and LTE features.

08 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

SLE: Wireless security techniques.

08 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.

08 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, Multipathdoppler effects

08 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.

SLE: Wireless MAN, 802.16X -MAC layer services, CDMA access channel probing.

08 hours

References

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

E-Resource

1. Video Lecture: https://nptel.ac.in/courses/117102062/4

Subject Name & Code	**Power Electronics – EC730**
No. of Teaching Hours: 40, Practical: 12 Sessions.	**Credits : 3:0:1 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Explain the principles and importance of various power semiconductor devices and analyze their characteristics for power electronics applications.
2. Design and analyze firing and protection circuits for different power switching devices.
3. Illustrate the importance of controlled rectifiers and AC voltage controllers with R and R-L load, and determine their performance parameters.
4. Demonstrate necessary skill sets related to the analysis and design concepts of DC-DC converters, methods of chopper control for different applications.
5. Explain the principles and voltage control methods of inverters and evaluate their performance.
6. Demonstrate and verify the concepts and working of power electronic circuits experimentally in the laboratory with duly prepared report.

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

References

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.

Laboratory 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.

Subject Name & Code	**Networking Lab – EC71L**
No. of Teaching Hours: 36	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	**SEE Marks: -**

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

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

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

Subject Name & Code	**Project Phase I – EC76P**
No. of Teaching Hours:	**Credits : 0:0:2.5 L-T-P**
CIE Marks: 50	**SEE Marks: -**

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

1. Identify and formulate a problem through adequate literature survey, taking into consideration, societal, environmental and sustainability issues.
2. Plan and schedule the execution of the problem by carrying out necessary design, anticipating bottlenecks and conforming to feasibility and budgetary aspects.
3. Submit a synopsis and an effective presentation.

PHASE	PARAMETERS FOR EVALUATION	M – 1	Total	M – 2	Total	M – 3	Total	M – 4	Total
Phase – 1	1. Problem formulation, analysis and design								
	2. Relevance of the problem								
	3. Ethical and Societal issues								
	4. Communication Skills								

	5. Teamwork								
Phase – 2	1. Design Process								
	2. Planning and scheduling								
	3. Feasibility analysis								
	4. Budgetary aspects								
	5. Teamwork								
Synopsis	1. Organization, material collection, and depth of content								
	2. Language, grammar, flow and organization of figures, tables, citations etc.								
Total		**M – 1**		**M – 2**		**M – 3**		**M – 4**	

Electives – VII Semester

	Department Electives (3:1:0)		Open Electives (3:1:0)
EC741	**Automotive Electronics**	**EC 751**	**IOT**
EC 742	**Nano science and Technology**	**EC752**	**Storage Area Networks**
EC743	**Digital satellite communication**	**EC753**	**Machine Learning**
EC744	**Quantum Computing and Communication**	**EC754**	**Cryptography & Network Security**
EC745	**Bio-Medical Signal Processing**	**EC755**	**Artificial Intelligence**
EC746	**Electronic Waste Management**	**EC756**	**Advanced Embedded System**
EC747	**Electro-magnetic Compatibility and Electro-magnetic Interference**		

Subject Name & Code	**Automotive Electronics – EC741**
No. of Teaching Hours: 40, **Tutorials: 12 Sessions.**	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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 explicate 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 of position, speed, rpm, acceleration, pressure, force, and torque, Flow meters, Gas sensors and concentration sensors, 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, Air mass 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.

Symbols and circuit diagrams: Circuit symbols & circuit diagrams, Designations for electrical devices, Terminal designations.

SLE: Wireless EV charging, advanced electric vehicle technology.

08 **hours**

References:

1. **Robert Bosch GmbH:** *Automotive Electrics Automotive Electronics,* 5th Edition, John Wiley & Sons Ltd, 2007.
2. **William B. Ribbens:** *Understanding Automotive Electronics,* 8th Edition, Elsevier, 2017.
3. **Tom Denton:** *Automobile Electrical and Electronic Systems*, 5th Edition, Taylor and Francis, 2017.

4. **James D. Halderman:** Automotive Electricity and Electronics, 5th Edition, Pearson, 2016.
5.

Subject Name & Code	Nano Science and Technology – EC742
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Acquire the knowledge on fundamental concepts of nanostructures, nanometer length scale and fabrication processes.
2. Comprehend spectroscopic techniques with property measurement.
3. Acquire the knowledge on quantum confinement, physical processes and characterization.
4. Identify the methods of preparing self-assembling nano structured molecular materials, nonmagnetic materials and devices.
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: Isolated atom, bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale.

SLE: Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nano systems.

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 and depth profiling: electron, mass, Ion beam, Reflectometry,

SLE: Techniques for property measurement: mechanical, electron, magnetic, thermal properties.

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. Physical processes: modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption. Characterization of semiconductor nanostructures: optical electrical and structural.

SLE: Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing.

08 hours

UNIT 4

Properties of nanoparticles: metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis (RF, chemical, thermolysis, pulsed laser methods) Carbon nanostructures and its applications. Self assembling nano structured molecular materials and devices: building blocks, principles of selfassembly, methods to prepare and pattern nanoparticles, templated nanostructures.

SLE: Nanomagnetic materials and devices: magnetism, materials, magneto resistance, nanomagnetism in technology, challenges facing nanomagnetism.

08 hours

UNIT 5

Introduction to Bionanotechnology: New tools in biological systems, Biomimetic nanotechnology: DNA as building block, Moleculer electronics and its applications, Applications of FET label free electrical DNA biosensor arrays, single crystalline silicon, thin film transistor arrays, field effect DNA testing.

SLE: Electrochemcial impedance spectroscopy, Biosensor arrays.

08 hours

References

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.
4.

Subject Name & Code	Digital satellite communication – EC743
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Explain the basic concepts of orbital mechanics, satellite subsystem and multiple access techniques of satellites
2. Apply the basic concepts to identify the satellites design criteria, testing and tracking.
3. Analyze the GPS concepts to find Position, Altitude and Latitude.
4. Explore the different application for satellite communication.
5. 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 and Trajectories: Definition, Basic Principles, Orbital parameters, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite's performance, Eclipses, Look angles: Azimuth angle, Elevation angle.

08 Hours

UNIT 2

Satellite subsystem: Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Payload. Earth Station: Types of earth station, Architecture, Design considerations, Testing, Earth station Hardware, Satellite tracking.

08 Hours

UNIT 3

Multiple Access Techniques: TDMA, CDMA, FDMA, SDMA, SCPC and MCPC system.

Communication Satellites: Introduction**,** Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, Regional satellite Systems, National Satellite Systems.

08 Hours

UNIT 4

GPS Concept: Introduction, GPS Performance Requirements, Basic GPS Concept, Basic Equations for Finding User Position, Measurement of Pseudo-range, Solution of User Position from Pseudo-ranges, Position Solution with more than Four Satellites, User Position in Spherical Coordinate System, Earth Geometry, Basic Relationships in an Ellipse, Calculation of Altitude, Calculation of Geodetic Latitude, Calculation of a Point on the Surface of the Earth, Satellite Selection, Dilution of Precision.

08 Hours

UNIT 5

Remote Sensing Satellites: Classification of remote sensing systems, orbits, Payloads, Types of images: Image Classification, Interpretation, Applications.

Weather Forecasting Satellites: Fundamentals, Images, Orbits, Payloads, Applications.

Navigation Satellites: Development of Satellite Navigation Systems, GPS system, Applications.

Indian satellite scenario, antenna for satellite systems, link budget (UL and DL), satellite for mobile applications.

08 Hours

Self-learning components: INSAT, VSAT, Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB)- Worldspace services, Business TV(BTV).

References

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

E –Resources

1. http://bigsemite.tripod.com/mcgraw.pdf
2. http://nptel.ac.in/courses/117105131/

Subject Name & Code	Quantum Computing and Communication - EC744
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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 behaviour of quantum networks.

UNIT 1

Quantum theory of light: Quantization of the electromagnetic field, evolution of the field operators, quantum states of the electromagnetic field.

8 Hours

UNIT 2

Quantum information processing: Quantum Optical Communication Quantum information processing: quantum information, quantum communication, quantum computation with qubits, quantum computation with continuous variables. Density operators and super operators, fidelity, entropy, information and entanglement measures, correlation functions and interference of light, photon correlation measurements.

08 Hours

UNIT 3

Photon sources and detectors: Photon sources and detectors: Mathematical model of photo detectors, physical implementations of photo detectors, single-photon sources, entangled photon sources, quantum non-demolition photon detectors.

08 Hours

UNIT 4

Quantum communication with single photons: Quantum communication with single photons: photons as information carriers, quantum teleportation and entanglement swapping, decoherence-free subspaces for communication, quantum cryptography. Quantum computation with single photons.

08 Hours

UNIT 5

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:

Solid-state quantum information carriers: Definition and optical manipulation of solid-state qubits, interactions in solid-state qubit systems, entangling two qubit operations, scalability of solid-state devices.

References

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

Subject Name & Code	Bio-Medical Signal Processing – EC745
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Identify the difficulties in biomedical signal by analysis.
2. Explain the sources of biomedical signals and their characteristics in relation with human physiology.
3. Analyze the basics of neurological signal modeling.
4. Demonstrate the noise elimination techniques using different algorithms.
5. Apply the knowledge of signal processing to analyze the various events and waveform complexities of different biological signals.
6. Work, document and present as an individual and as a team-member to design formulate 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.

References

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
   downloads.hindawi.com/journals/special issues/129194.pdf
5.

Subject Name & Code	Electronic Waste Management – EC746
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Identify the problems of municipal waste, hazardous waste, e waste, industrial waste.
2. Evaluate the various strategies on waste management.
3. Summarize the knowledge of regulations, guidelines, legal, institutional aspects of management of e-wastes.
4. Illustrate the various methods of recycling and recovery of earth metals from e-waste.
5. Explain the technical issues of treatment options for e-waste.

UNIT 1

Introduction to Solid hazardous and E- waste: Introduction, 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, E-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

UNIT 4

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

Physicochemical 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); groundwater contamination and remediation,

08 Hours

Self-learning components: 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.

References

1. **Rakesh Johri**: **"***E-waste: Implications, regulations, and management in India and current global best practices"*, 2016
2. **Freeman M. H:** "*Standard Handbook of Hazardous Waste Treatment and Disposal"*, McGraw-Hill Company, USA 1989.
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**.**

E-Resource:

1. *http://wgbis.ces.iisc.ernet.in/energy/paper/ewaste/ewaste.html*

2. *http://meity.gov.in/esdm/e-waste*
3. *http://www.nptel.ac.in/courses/120108005/module9/lecture9.pdf*

Subject Name & Code	**Electro-magnetic Compatibility and Electro-magnetic Interference - EC747**
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Demonstrate the basic knowledge related to EMI and EMC principles.
2. Apply the knowledge of EMI/EMC in prototyping an electronic component.
3. Analyze through knowledge acquisition with regard to Noise Coupling, Noise reduction and EMI suppression.
4. Explain the importance of signal integrity and EMI.
5. Explain the impact of EMI compliance, IEEE EMI standards.
6. Work in groups, communicate effectively and document outcomes related to recent trends and techniques using simulation tools and ICT

UNIT 1

Introduction of EMC, Electromagnetic environment, History, concept, Natural and intentional source of EMI, EMC in Commercial, automobile, defense and Aviation product. Introduction to radiated and conducted emissions testing and limits. Electromagnetic field theory - Description of electromagnetic disturbances, classification based on frequency, transmission and character.; Near field vs Far field.

08 Hours

UNIT 2

Noise Coupling Mechanisms: Conductive coupling, capacitive coupling and Inductive coupling, electromagnetic coupling. Types of EMI Intra and Inter .Current loops, Differential mode and , Decoupling capacitor – selection, values & resonant frequencies, Decoupling capacitor placements & routing;- Demonstration – Dielectrics, Via placement, Return paths**.**

08 Hours

UNIT 3

Techniques to Optimize power delivery network, grounding, shielding, bonding, reducing internal EMI, EMI Filter design. Insertion loss versus frequency of EMI filter. Cable radiation and interference. EM coupling wiring layout and PCB design considerations, Shielding-coaxial cables, shielding of equipment,

EMC suppression cable, EMC gaskets.

08 Hours

UNIT 4

Introduction to signal integrity and EMI, Impedance mismatches, reflections, and manufacturing effects, Termination methods and routing topologies, Crosstalk and guarding, causes of EMI from high speed digital circuits, need for Shielding.

08 Hours

UNIT 5

Introduction to IEEE Standards - EMC compliance, testing of Electrical/ Electronic product for Conducted and Radiated emission, Conducted and Radiated immunity parameters as per standards. EMI measuring instruments, spectrum analyzer, LISN, Current probe, anechoic chambers, Field Probe.

08 Hours

Self-learning components: Unintentional antennas, common mode noise in digital circuits, Isolation transformer, SMPS design for low conducted emissions, EMC Antenna

References

1. Electromagnetic Compatibility Design Guide", Tecknit. 2009.(e-book)
2. Noise Reduction Techniques in Electronic System: H.W.Ott.John Wiley, 2007.
3. New Dimensions in Shielding, Robert B. Cowdell, IEEE transactions on Electromagnetic Compatibility. (Journal Paper)
4. EMI Standards: Prasad Kadali. PHI, 2011.

E-book:

1. Electromagnetic Compatibility Engineering by Henry W. Ott, John wiley& Sons 2009 edition.
2. Video lecture- EMI & EMC by Ms. Mayanka Kaushik. Assistant Prof, Biyani International Institute of Engineering & Technology 2014

Subject Name & Code	Internet Of Things – EC751
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. 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. Analyze and apply the communication protocols suitable for IOT
4. Identify and analyze the Embedded Devices for IOTs.
5. Apply and demonstrate the application of IOT in various fields.
6. 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 Service oriented protocols (COAP).-Communication protocols based on the exchange of messages XMPP, AMQP.

08 hours

UNIT 4

Zigbee: Zigbee architecture, routing algorithm, security, Zigbee cluster library IEEE 802.15.4, 6LowPAN, RFID, NFC, Arduino , Raspberry Pi , Embedded Devices for IoT.

08 hours

UNIT 5

Smart Grid, Home Automation, Smart City, agriculture, health care, IoT,

08 hours

Self-learning components: Wearables, Smart Cities, Smart Retail, Blockchain, AI and Big data.

References

1. **Raj Kamal,** *"Internet of Things: Architecture and Design Principles",* 1st Edition, McGraw Hill Education, 2017.
2. **RajkumarBuyya: "***Internet of Things: Principles and Paradigms"*, McGraw Hill Education, 2017.
3. **Olivier Hersent: "***The Internet of Things",* Willey student edition, Reprint, 2015.
4. **Jan Holler: "***From Machine-to-Machine to the Internet of Things"*, Academic Press, 2014.
5. **ArshdeepBahga: "***Internet of Things",* Universities press, 2015.

E-Resource

1. http://nptel.ac.in/courses/106105166/
2. http://www.allitebooks.in/the-internet-of-things/

Subject Name & Code	Storage Area Networks – EC752
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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 Fibre Channel, The SAN and Its Evolution, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel Architecture, Zoning, Fibre 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.

References:

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. Videos Lecture link : nptel.ac.in/courses/106108058/

Subject Name & Code	**Machine Learning – EC753**
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Explain the importance of machine learning, its perspectives and issues.
2. Illustrate the knowledge of various decision tree methods.
3. Identify and illustrate the role of artificial neural networks in the context of machine learning
4. Apply the knowledge on probabilistic learning methods.
5. Evaluate the theoretical characterization and capabilities of machine learning algorithms.
6. Work effectively as a member or a leader in teams to implement assigned tasks related to advanced topics.

UNIT 1:

Basic Principles: Introduction, Well-Posed Learning Problems, Designing a Learning System, Perspectives and Issues in Machine Learning, The concept learning task, Concept Learning as search,General-to-specific ordering of hypotheses, Version spaces and the Candidate-Elimation, Experimental Evaluation: Over-fitting, Cross-Validation.

SLC: Find-S:Finding a Maximally Specific Hypothesis, Inductive bias, Remarks on Version Spaces and Candidate-Elimation.

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.

SLC: Decision Theory: Minimizing the misclassification rate, Minimizing the expected loss, the reject option, Inference and Decision, Information theory: Relative entropy and mutual information.

08 Hours

UNIT 3: Artificial Neural Networks

Neural Network Representation, perception, 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

SLC: Evaluating Hypotheses, Motivation, Estimating Hypothesis Accuracy, Basics of Sampling Theory, a General Approach for Deriving Confidence Intervals

UNIT 4: Probabilistic Learning

Bayesian Learning: Bayes Theorem, Bayes Theorem and Concept Learning, Maximum Likelihood Hypothesis for predicting Probabilities, Gibbs Algorithm, Bayesian Belief Networks: Conditional Independence, Representation, Inference, Learning Bayesian Belief Networks, Gradient Ascent Training of Bayesian Networks, Learning the structure of Bayesian Networks.

08 Hours

SLC: The EM Algorithm: Estimating Means of k Gaussinas, General Statement of EM Algorithm, Derivation of the k Means Algorithm

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 Neighbor Learning.

08 Hours

SLC: TheMistake Bound Model of Learning, Locally Weighted Regression, Radizl Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning

References:

1. **Tom Mitchell.***Machine Learning,* Indian Edition,McGraw Hill, 1997.
2. **Christopher M. Bishop.***Pattern Recognition and Machine Learning*.1st edition, Springer 2006.

E-Resource

1. https://www.youtube.com/watch?v=OGxgnH8y2NM&list=PLQVvvaa0QuDfKTOs3Keq_kaG2P55YRn5v
2. https://www.youtube.com/watch?v=T3PsRW6wZSY&list=PLlGkyYYWOSOsGU-XARWdIFsRAJQkyBrVj

Subject Name & Code	**Cryptography & Network Security – EC754**
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	**Credits : 3:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Acquire and demonstrate the knowledge of Cryptographic and Network Security Architecture.
2. Explain various encryption standards, methods and systems
3. Verify and analyze the functionality of cryptographic algorithms by writing codes
4. Understand issues of security at various network layers and their solutions
5. Validate network security procedures using open - tools.
6. Work as small teams adhering to standard ethics, promoting entrepreneurial spirit to innovatively implement ideas and document outcomes related to recent trends.

UNIT 1:

Introduction: Goals, Services, mechanisms and attacks. The OSI security architecture, A model for network security. TRADITIONAL SYMMETRIC-KEY CIPHERS**:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques stream and block ciphers modern symmetric-key ciphers: modern block ciphers, modern stream ciphers, SLE Topics

08 Hours

UNIT 2:

Simplified DES, Data encryption standard (DES). The strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of Operation, Advanced Encryption Standard, The AES Cipher Analysis, SLE Topics

08 Hours

UNIT 3:

Principles of Public-Key Cryptosystems, The RSA algorithm, Key Management, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Authentication functions and Hash Functions., SLE Topics

08 Hours

UNIT 4:

Digital signatures, Authentication Protocols, Digital Signature Standard. Web Security Consideration, Security socket layer (SSL) and Transport layer security, Secure Electronic Transaction SLE Topics

08 Hours

UNIT 5:

Intruders, Intrusion Detection, Password Management. MALICIOUS SOFTWARE: Viruses and Related Threats, Virus Countermeasures. Firewalls Design Principles. SLE Topics of recent interest from journals and magazines

08Hours

References

1. **William Stallings: "***Cryptography and Network Security",* 4th Edition, Pearson Education, 2003.
2. **Behrouz A. Forouzan: "***Cryptography and Network Security"*, 2nd Edition, TMH, 2007.

3. **Kaufman, Perlman & Speciner: "***Network security -Private communication in a public world*", PHI, 2nd Edition 2005.

E-Resource

1. http://nptel.ac.in/courses/106105031/

Subject Name & Code	Artificial Intelligence – EC755
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Analyze the dimensions along which agents and environment with percepts.
2. Analyze and evaluate the various issues in design problems.
3. Implement search models using different search strategies.
4. Illustrate the logic for representing knowledge and reasoning of logical agents.
5. Enumerate different learning algorithms with its performance.
6. Work effectively as an individual and a team-member to design formulate and implement using modern tools.

UNIT 1

Introduction: Intelligent Agents, Agents and environment, Rationality, the nature of environment, the structure of agents, Goal based agents, Utility based agents, Learning agents.

08 Hours

UNIT 2

Problem-solving: Problem space & search, defining the problem as state space search, production system, Problem characteristic, Issues in the design of search programs.

08 Hours

UNIT 3

Search Techniques: Searching for Solutions, Uninformed Search Strategies, Breadth First search, Depth First Search, Iterative deepening depth first search, Informed Search Strategies, Heuristic functions, Greedy best first search, A*search.

08 Hours

UNIT–4

Logical Agents: Knowledge –based agents, The Wumpus world, Logic-Propositional logic, Propositional theorem proving, Effective propositional model checking Agents based on propositional logic.

Using predicate logic: Representing simple facts in logic, Computable functions and predicates, Resolution, Forward reasoning, backward reasoning.

08 Hours

UNIT–5

Learning: Forms of Learning; Inductive learning, Learning decision trees, Explanation based learning, learning using relevance information, Neural net learning & genetic learning.

08 Hours

Self-learning components:

Speech Recognition, Classification using Adaboost, Face detection, and Neural Networks.

References:

1. **Artificial Intelligence: A Modern Approach** by Stuart Russel, Peter Norvig, 2nd Edition, Pearson Education, 2003.
2. **Artificial Intelligence**, by Elaine Rich, Kevin Knight, Shivashankar B Nair: Tata MCGraw Hill 3rd edition. 2013**.**
3. **Artificial Intelligence** by George F Luger, 5th Edition Pearson Education, 2009.

Subject Name & Code	Advanced Embedded System – EC756
No. of Teaching Hours: 40, Tutorials: 12 Sessions.	Credits : 3:1:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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.

08 Hours

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

SLE: RTOS scheduling, Device Drivers.

References

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.

VIDEO LECTURES:

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

Subject Name & Code	**Entrepreneurship and Management – EC810**
No. of Teaching Hours :52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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.

10 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.

12 hours

UNIT 3

Engineering Management: Introduction to Engineering Management**:** Engineering and Management, historical development of engineering management.

10 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. Related case Studies.

10hours

UNIT 5

Project Report Preparation: Business organizations and business laws, IPR, financial management in enterprise, preliminary project report, techno-economic feasibility report, project viability, case studies examples.

10 hours

References:

1. **Peter Duckers, Heinnemann:** "*Innovation and Entrepreneurship Practice and Principles*", 1st Edition, Taylor and Francis, 1986.
2. **Morse and Babcock:** "*Managing Engineering and Technology*", 4th Edition, PHI Learning Private Limited, New Delhi, 2009.
3. **Poornima M. Charantimath:** "*Entrepreneurship Development and Small Business Enterprises*", 2nd Edition, Pearson education, 2014.
4. **Weihrich, Cannice, Koontz, Management:** "*A Global, Innovative and Enterpreneurial Perspective*", 14th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

Electives – VIII Semester

	GROUP A (4:0:0)		GROUP B (4:0:0)
EC 821	Digital Compression Techniques	EC 831	Wireless sensor networks
EC 822	Low power VLSI Design	EC 832	Mobile Computing
EC 823	Big data and analytics	EC 833	Wavelet Transforms
EC 824	Medical Instrumentation	EC 834	Operations Research
EC 825	Optical Networks	EC 835	Cloud Computing
EC826	System On Module – SOM	EC836	Hybrid Vehicles

EC827	**Protocol Engineering**	**EC837**	**Optoelectronic Materials and Devices**

Subject Name & Code	**Digital Compression Techniques – EC 821**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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 data compression. Acquire knowledge on fundamental concepts of lossy compression techniques.
4. Acquire comprehensive knowledge on quantization techniques and transform coding.
5. Acquire knowledge on basic concepts 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: 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.

10 hours

UNIT 2

Huffman coding algorithm, Adaptive Huffman coding, Applications of Huffman coding to text and audio processing, Arithmetic coding, generating and deciphering the tag, Binary coding, Comparison with Huffman coding, Adaptive arithmetic coding and applications.

10 hours

UNIT 3

Dictionary techniques: static/adaptive dictionary, Applications: UNIX compress, GIF image compression, JPEG, JPEG-LS *lossless* compression techniques, Mathematical preliminaries for *Lossy* Compression techniques: Distortion criteria, conditional entropy, differential entropy, Models: physical, probabilistic, linear system models.

11 hours

UNIT 4

Scalar quantization, uniform, Adaptive quantizer, Vector quantization, Advantages of VQ over SQ, LBG algorithm. Transform coding: Karhunen-Loeve transform, DCT, Quantization and coding of transform coefficients, JPEG for image and Modified DCT for audio compression.

11 hours

UNIT 5

Sub band coding algorithm: analysis, quantization, coding, synthesis, Wavelets: Multi-resolution analysis and scaling function, implementation using filters, image compression using wavelets, Embedded Zerotree Coder, Set partitioning in Hierarchical tress, JPEG 2000.

10 hours

References

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.

Subject Name & Code	**Low power VLSI Design – EC 822**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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.

10 Hours

UNIT 2

Synthesis for Low power: Low-Power - Gate-Level Design, Architecture-Level Design, Algorithmic-Level Power Reduction, RTL Techniques for Optimizing Power.

10 Hours

UNIT 3

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.

11 Hours

UNIT 4

Low Power Circuits: Logic Families, Low-Power and Standard Cell Libraries, Logic Styles for Specific Applications - Library Cells for Self-Timed Design, Library Cells for Cryptographic Applications, SEU-Tolerant Logic Single-Clock Latches and Flip-Flops, High-Throughput CMOS Circuit Techniques, Fast and Efficient CMOS Functional Circuits, the Future of Dynamic Logic.

11hours

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.

10 hours

References:

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

Subject Name & Code	Big data and analytics - EC823
No. of Teaching Hours : 52	Credits : 4:0:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Comprehend the architectural elements of big data
2. Analyze the various database models for big data
3. Apply big data analytics using HDFS and Map Reduce
4. Comprehend the knowledge of Big Data applications using Pig and Hive.
5. Design and implement big data analytics for various application
6. Work in a team, complete assignment and present results in written and oral form

UNIT 1

Introduction to Big Data: Types of Digital Data – Classification of Digital Data. Introduction to Big Data – Characteristics of Data, Evolution of Big Data, Definition of Big Data, Challenges with Big Data Terminologies Used in Big Data Environments, Basically Available Soft State Eventual Consistency (BASE).

10 Hours

UNIT 2

Hadoop: History of Hadoop-The Hadoop Distributed File System –Components of Hadoop-Analyzing the Data with Hadoop-Scaling Out-Hadoop Streaming -Design of HDFS-Java interfaces to HDFS Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort –Task execution -Map Reduce Types and Formats-Map Reduce Features

11 Hours

UNIT 3

MongoDB: Introduction to MongoDB, Terms Used in RDBMS and MongoDB, Data Types in MongoDB, MongoDB Query Language. Cassandra – Apache Cassandra - An Introduction , Features of Cassandra, CQL Data types, CQLSH, Keyspaces, CRUD (Create, Read, Update and Delete) Operations, Collections,

Using a Counter, Time to Live (TTL), Alter Commands, Import and Export, Querying System Tables, Practice Examples.

10 Hours

UNIT 4

Hadoop Environment: Setting up a Hadoop Cluster - Cluster specification -Cluster Setup and Installation –Hadoop Configuration -Security in Hadoop -Administering Hadoop –HDFS -Monitoring-Maintenance -Hadoop benchmarks - Hadoop in the cloud

10 Hours

UNIT 5

Frameworks: Applications on Big Data Using Pig and Hive –Data processing operators in Pig –Hive services –HiveQL –Querying Data in Hive -fundamentals of HBase and ZooKeeper -IBM InfoSphere Big Insights and Streams. Visualizations -Visual data analysis techniques, interaction techniques; Systems and applications

11 Hours

References

1. **Michael Berthold, David J. Hand:** "*Intelligent Data Analysis*" 2nd Edition, Springer, 2007.
2. **Tom White:** " *Hadoop: The Definitive Guide*" 3rd Edition, O'reilly Media, 2015
3. **Chris Eaton, Dirk DeRoos**, **Tom Deutsch, George Lapis, Paul Zikopoulos:** "*Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data*", 1st Edition, McGraw Hill Publishing, 2012.
4. **Seema Acharya, Subhashini Chellappan:** "*Big data and Analytics*", 1st Edition, Wiley publications, 2014.

Subject Name & Code	**Medical Instrumentation – EC 824**
No. of Teaching Hours :52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Acquire the knowledge on origin of various bioelectric signals and issues related to its acquisition.
2. Acquire the knowledge on the acquisition of bioelectric signals and understand the applications of pacemakers and defibrillators.
3. Investigate the various lifesaving diagnosis and therapeutic instruments.
4. Comprehend the various patients monitoring system and understand the concept of telemedicine.
5. Acquire knowledge on the basic components and working principle behind different imaging modalities.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

UNIT 1

Bioelectric Signals and Electrodes: Sources of biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems, Origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrodes – Electrode-tissue interface, Polarization, Skin contact impedance, Motion artifacts, Silver-Silver Chloride electrodes, Electrical conductivity of electrode jellies and creams.

10hours

UNIT 2

Acquisition of Bioelectrical signals and Pacemakers: Electrodes for ECG, ECG leads, Effects of artifacts, Multi-channel ECG machine, Vector cardiograph, Phonocardiograph, Electrodes of EMG, Electrodes for EEG, 10-20 electrode systems, computerized analysis of EEG, Pacemakers & Defibrillator: Need for cardiac pacemaker, External pacemaker, Implantable pacemakers-types, Need for defibrillator, DC defibrillator, Automatic external defibrillator, Implantable defibrillators

11 hours

UNIT 3

Diagnosis and Therapeutic Instruments: Spirometry: Basic spirometer, Ultrasonic spirometer, Ventilators, types, Modern ventilators, High frequency ventilators, Nebulizers, Artificial Kidney: Introduction, Dialyzers, Membranes for Hemodialysis, Hemodialysis machine, Oximetry, Blood flow measurement by Doppler imaging, Nuclear Magnetic Resonance& Laser Doppler flow meter.

10 hours

UNIT 4

Patient Monitoring Systems and Telemedicine: Cardiac monitor, Bedside patient monitoring system, measurement of heart rate-average and instantaneous heart rate meters, Measurement of pulse rate, Blood pressure measurement: Direct method, Indirect method-automatic pressure measurement using Korotkoff's method, Single channel telemetry systems, Multichannel wireless telemetry systems, Multi-patient telemetry, Telemedicine applications, Essential parameters for telemedicine, Telemedicine technology.

11hours

UNIT 5

Medical Imaging Systems: Basic components and working principle of X-rays, Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI)& Radionuclide Imaging.

10 hours

References

1. **R.S.Khandpur:** "*Handbook of Biomedical Instrumentation"*, 2nd Edition, Tata McGraw Hill, 2003
2. **Kirk Shung, Michael Smith and Benjamin M.W Tsui:** "*Principles of Medical Imaging"*, 1st Edition, Academic Press limited, 1992.
3. **Jerry L Prince and Jonathan M Links:** "Medical Imaging Signals and Systems**",** 2nd Edition, Pearson/Prentice Hall of India, 2014.
4. **Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer:** "*Biomedical Instrumentation and Measurement",* 2nd Edition, Prentice-Hall India, 2001.

Subject Name & Code	Optical Networks – EC 825
No. of Teaching Hours: 52	Credits : 4:0:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Explain the physical properties and protocols applied in optical networks.
2. Analyze the optical switching methods and networking techniques.
3. Evaluate performance of optical packet switched nodes using discrete event simulation methods.
4. Design optical networks, taking both physical transmission properties and optical networking constraints into account.

UNIT 1

Introduction to Optical Networks: Telecommunication networks, First generation optical networks, Multiplexing techniques, Second generation optical networks, System and network evolution. Nonlinear effects SPM, CPM, four wave mixing, Solitons.

10Hours

UNIT 2

Components: Couplers, isolators and Circulators, Multiplexes and filters Optical amplifiers. Transmitters, detectors, Switches, Wavelength converters.

10Hours

UNIT 3

Transmission System Engineering: System model, Power penalty, Transmitter, receiver, optical amplifiers, Crosstalk, Dispersion, Overall design Consideration. First Generation Networks: SONET/SDH, Compute interconnects, Mans, Layered architecture for SONET and second generation networks.

11Hours

UNIT 4

Wavelength Routing Networks: Optical layer, Node design, Network design and operation, routing and wavelength assignment architectural variations. Virtual Topology Design: Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies, Control and management, Network management configuration management, Performance management, fault management.

11Hours

UNIT 5: Access Networks

Network architecture overview, present and future access networks, HFC, FTTC, Optical access networks Deployment considerations, Photonic packet switching, OTDM, Multiplexing and demultiplexing Synchronization.

10Hours

References

1. **Kumar Sivarajan, Galen Sasaki and Rajiv Ramaswami:** "*Optical networks: A practical perspective*" Elsevier and Morgan Kaufmann publishing, 3rd Edition, 2009.
2. **Biswajit Mukherjee:** "*Optical communication networks*", McGraw-Hill Series, 1st Edition, 1997.
3. **Uyless D Black:** "*Optical Networks: Third Generation transport system*", Pearson education, 1st edition, 2002.

Subject Name & Code	**System On Module - SOM – EC 826**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Acquire knowledge on basics of CMOS and SoC.
2. Analyze the circuits quantitatively for performance maximization.
3. Analyze the design flow with types of SoC with timing issues and verification.
4. Design of cache memory, Flash memory with MESI protocol.
5. Analyze the Bus architectures for NoC communication.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

UNIT 1

Motivation for SoC Design - Review of Moore‟s law and CMOS scaling, benefits of system-on-chip integration in terms of cost, power, and performance. Comparison on System-on-Board, System-on-Chip, and System-in-Package. Typical goals in SoC design – cost reduction, power reduction, design effort reduction, performance maximization. Productivity gap issues and the ways to improve the gap – IP based design and design reuse.

11 Hours

UNIT 2

System On Chip Design Process: A canonical SoC Design, SoC Design flow, waterfall vs spiral, top down vs bottom up, Specification requirement, Types of Specification, System Design Process, System level design issues, Soft IP vs Hard IP, IP verification and Integration, Hardware-Software codesign, Design for timing closure, Logic design issues, Verification strategy, On chip buses and interfaces, Low Power, Hardware Accelerators in Soc.

11 Hours

UNIT 3

Embedded Memories: cache memories, flash memories, embedded DRAM. Topics related to cache memories. Cache coherence. MESI protocol and Directory-based coherence.

10 Hours

UNIT 4

Interconnect architectures for SoC: Bus architecture and its limitations. Network on Chip (NOC) topologies. Mesh-based NoC. Routing in a NoC. Packet switching and wormhole routing.

10 Hours

UNIT 5

MPSoCs: What, Why, How MPSoCs, Techniques for designing MPSoCs, Performance and flexibility for MPSoCs design

10 Hours

References

1. **Sudeep Pasricha and Nikil Dutt:** "*On-Chip Communication Architectures: System on Chip Interconnect*", 1st Edition, Morgan Kaufmann Publishers © 2008.
2. **Rao R. Tummala, Madhavan Swaminathan:** "*Introduction to system on package sop Miniaturization of the Entire System*", 1st edition, McGraw-Hill, 2008.
3. **James K. Peckol: "***Embedded Systems: A Contemporary Design Tool*", Wiley Student Edition, 2008.
4. **Michael Keating, Pierre Bricaud:**"*Reuse Methodology Manual for System on Chip designs*", Kluwer Accademic Publishers, 2nd edition, 2008.

5. **Sung-Mo Kang, Yusuf Leblebici**, "*CMOS Digital Integrated Circuits*", 3rd Edition, Tata McGraw-Hill, 2002.

Subject Name & Code	**Protocol Engineering – EC 827**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Explain the fundamental concepts of communication protocol, its architecture and working
2. Design and simulate simple protocols using formal and informal approaches.
3. Recognize the different protocol specification and realize about various concepts of SDL.
4. Explain protocol testing, error testing procedures using different methods

5. Demonstrate the knowledge of developing simple protocols, their testing and writing test cases keeping abreast of industry preferences.
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

Communication model, Communication software, Communication subsystems, protocol development methods, protocol engineering process. Network reference model: services and interfaces, protocol functions, OSI and TCP/IP model, Host to network interface protocols, network protocols transport protocols, application protocols.

10hours

UNIT 2

Protocol specifications: Components of protocol, service specifications, entity specifications, interface and interactions, multimedia protocol specifications, HDLC, ABP and RSVP specifications.

10hours

UNIT 3

SDL: features, communication system using SDL, examples of SDL based protocol specifications, other specification languages; Protocol verification, FSM based verification, validation, design errors, validation approaches, verification and validation of ABP using SDL.

12 Hours

UNIT 4

Conformance testing, framework, conformance test architectures, test sequence generation methods, TTCN, multimedia testing, MPLS testing.

10 Hours

UNIT 5

Performance testing methods, testing of TCP and OSPF, interoperability testing, scalability testing.

10 Hours

Self-learning topic: Protocol synthesis algorithms, various methods & requirements of protocol implementation

References

1. **Pallapa Venkataram, Sunil Kumar Manv**i: "*Communication Protocol Engineering*", 2nd Edition, PHI Learning, 2014.
2. **Gerard. J. Holtzmann**: "*Design and validation of Computer protocols*", 1st Edition, Prentice hall, 1991 (available on web)
3. **K. Tarnay**: "*Protocol specification and testing*", 1st Edition, Plenum press, 1991.
4. **Miroslav Popovic:** "*Communication protocol Engineering*", 2nd Edition, CRC press, 2018.
5. **Hartmut Konig:** "*Protocol Engineering*", 1st Edition, Springer, 2012.

Subject Name & Code	**Wireless sensor networks– EC 831**

No. of Teaching Hours : 52	Credits : 4:0:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

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.

Course Prerequisites: Basic Knowledge of Computer Networks, Sensors and any Programming language.

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.

12 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.

10 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.

10 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.

10 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.

10 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.

References:

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/ --- (By Prof. Sudip Misra, IIT Kharagpur)
2. http://www.tfb.edu.mk/amarkoski/WSN/Kniga-w02 ---- (Wireless Sensor Networks Text book – PDF)
3. https://pdfs.semanticscholar.org/e87f/5253451603be6ef1b5d56700ed8048a33d61.pdf -- (Fundamentals of Wireless Sensor Networks text book PDF).
4. http://profsite.um.ac.ir/~hyaghmae/ACN/WSNbook.pdf -- (Protocols and Architectures for Wireless sensor Networks textbook PDF).

Subject Name & Code	**Mobile Computing – EC 832**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

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. Outline and illustrate 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.

11 Hours

UNIT 2

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

10 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.

11 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

10 Hours

Unit 5

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

10 Hours

References

1. **Yi Bing Lin and Imrich Chlamtac**: "*Wireless and Mobile Networks Architecture*", 3rd Edition, John Wiley,2008
2. **Uwe Hansmann, Lothar Merk, Mertin S Nickloue and Thomas Stober:** "*Principles of Mobile Computing*" Second Edition, Springer International Edition, Springer Professional Computing, 2003.
3. **Reza B'Far:** "*Mobile Computing Principles*", First edition, Cambridge University Press.
4. **Raj Kamal:** "Mobile Computing", Second Edition, Oxford University Press,2013
5. **Ashoke K Talukder, Hasan Ahmed and Roopa R Yavagal**: "*Mobile Computing*", Second Edition, Tata McGraw Hill, 2010.

VIDEO LECTURES:

1. NPTEL Wireless Communication series.
2. https://www.youtube.com/watch?v=5MoIg5lWLXA
3. https://www.youtube.com/watch?v=tt1-Ohe9QQU
4. https://www.youtube.com/watch?v=Rjluns-AEnc
5. https://www.youtube.com/watch?v=oxTUC5I22LU&list=PLE6yE0jB6BTMJXIXw4PS1kOqqZ9ty7eoG
6. https://www.youtube.com/watch?v=uIPtLr8R1-U&list=PLE6yE0jB6BTOY6Z1DKEkQ8yZ8fFPUiCD8
7. https://www.youtube.com/watch?v=UnoeO5kS2OQ
8. https://www.youtube.com/watch?v=1POzl9tZXuQ&list=PL-XjHn7CHrmTdl365uztpUVLx4zwbFgbl

Subject Name & Code	**Wavelet Transforms – EC 833**
No. of Teaching Hours :52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Explain the concept of Vectors, Basis Sets and Signal Representation, analyze discrete time signals using Wavelets
2. Analyze discrete time signals using Wavelets.
3. Analyze continuous time signals using continuous wavelets.
4. Apply wavelets for audio, image and video applications using software tool by executing projects in a team
5. Evaluate efficient computation techniques for DWT.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

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.

12 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

10 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

10 Hours

UNIT 4

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

10 Hours

UNIT 5

Lifting wavelet scheme: Primal lifting, dual lifting, Polyphase representation, Laurent polynomials, Lifting properties and applications. **10 Hours**

References

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.

Subject Name & Code	Operations Research – EC 834
No. of Teaching Hours :52	Credits : 4:0:0 L-T-P
CIE Marks: 50	SEE Marks: 50

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

1. Acquire the knowledge on importance and significance of OR concepts and techniques.
2. Apply the concepts of linear programming and its applications to real life problems.
3. Analyze and apply methods used in transportation and assignment problems to practical cases.
4. Solve network optimization problems, integer programming and problems related to game theory.
5. Develop an awareness and familiarity about recent trends, software tools and techniques in OR and optimization.
6. Work effectively in a group, make use of simulation/ analysis tools to complete a given task.

UNIT 1

Introduction to OR, Overview of OR Modeling approaches, Introduction to Linear Programming assumptions, problem formulation.

11 hours

UNIT 2

Solving LP Problems, Simplex method, computer implementation, other algorithms for Linear programming dual simplex, parametric, upper bound and interior point algorithms.

11 hours

UNIT 3

Transportation and assignment problems. Network optimization methods examples, case studies

10 hours

UNIT 4

BIP, Integer Programming branch and bound, constraint programming capacity assignments.

10 hours

UNIT 5

Game theory, solving simple games, introduction to queuing theory, distributions, applications.

10hours

References

1. **Hiller and Lieberman**: "*Introduction to Operations Research*" 8th Edition TMH publications, Reprint 2007.
2. **Hamdy Taha**: "*Operations Research*", 8th Edition TMH publications, 2001.
3. **R. Pannerselvam**: "*Operations Research*", 2nd Edition, PHI publications, 2006.
4. **Wayne L. Winston**: "*Operations Research - Applications and Algorithms*", 4th Edition, Cenage Learning, 2003.
5. **Bronson and Naadimuthu:** "*Operations Research*" - Schaum's Series, 2nd Edition, TMH publications, 2005

Subject Name & Code	**Cloud Computing – EC 835**
No. of Teaching Hours :52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

- Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
- Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
- Explain the core issues of cloud computing such as security, privacy, and interoperability.
- Provide the appropriate cloud computing solutions and recommendations according to the applications used.
- Demonstrate the skill sets related to the usage of EDA tool for analysis and simulation.

UNIT 1

History of Centralized and Distributed Computing - Overview of Distributed Computing, Cluster computing, Grid computing. Technologies for Network based systems- System models for Distributed and cloud computing- Software environments for distributed systems and clouds.

12 Hours

UNIT 2

Introduction to Cloud Computing- Cloud issues and challenges - Properties - Characteristics - Service models, Deployment models. Cloud resources: Network and API - Virtual and Physical computational

resources - Data-storage. Virtualization concepts - Types of Virtualization- Introduction to Various Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs.

10 Hours

UNIT 3

Service models - Infrastructure as a Service (IaaS) - Resource Virtualization: Server, Storage, Network - Case studies. Platform as a Service (PaaS) - Cloud platform & Management: Computation, Storage - Case studies. Software as a Service (SaaS) - Web services - Web 2.0 - Web OS - Case studies – Anything as a service (XaaS).

10 Hours

UNIT 4

Cloud Programming and Software Environments – Parallel and Distributed Programming paradigms – Programming on Amazon AWS and Microsoft Azure – Programming support of Google App Engine – Emerging Cloud Software Environment.

10 Hours

UNIT 5

Cloud Access: authentication, authorization and accounting - Cloud Provenance and meta-data - Cloud Reliability and fault-tolerance - Cloud Security, privacy, policy and compliance- Cloud federation, interoperability and standards.

10 Hours

References:

1. **Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra,** "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier – 2012
2. **Barrie Sosinsky**, "Cloud Computing Bible" John Wiley & Sons, 2010
3. **Tim Mather, Subra Kumaraswamy, and Shahed Latif**, "Cloud Security and Privacy an Enterprise Perspective on Risks and Compliance", O'Reilly 2009

E-Resource

1. Video Lecture: **http://nptel.ac.in/courses/106106129/28**

Subject Name & Code	**Hybrid Vehicles – EC 836**
No. of Teaching Hours :52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Analyze the different powertrain architecture options and select the appropriate solutions within realistic performance and commercial constraints.
2. Size various HEV subsystems, within the context of various vehicle constraints, such as performance, fuel economy and packaging.
3. Evaluate various technology options for (electrical and mechanical) energy generation, storage, transmission, and management for a HEV, and be able to select between different technologies relative to a given vehicle application and overall system design.

4. Employ and experiment rapid control prototyping techniques to design and validate Hybrid and Electric Vehicle sizing, high-level and low-level control systems.
5. Carry out performance evaluations, testing of a Hybrid and Electric Vehicle and its subsystems, using offline simulations.
6. Work effectively as a member or a leader in teams to implement assigned tasks related to advanced topics.

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.

EV/CEV Comparison, Plug-in Hybrid Electric Vehicles., PEV configurations.

10 hours

UNIT 2

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drivetrain topologies, power flow control in hybrid drivetrain 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

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 Switched Reluctance Motor drives, drive system efficiency.

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.

12 hours

UNIT 4

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

10 hours

UNIT 5

Vehicle Mechanics: Roadway Fundamentals, Laws of Motion, Vehicle kinetics, Dynamics of Vehicle Motion, power management for vehicle dynamics control.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), modelling of a HEV and its subsystems, Design of a Battery Electric Vehicle (BEV), cruise control, active suspensions, Antilock braking, traction control, vehicle stability & rollover protection

10 hours

References

1. **Iqbal Hussein:** "*Electric and Hybrid Vehicles: Design Fundamentals*", CRC Press, 2003.
2. **MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi:** "*Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*", CRC Press, 2004.
3. **James Larminie, John Lowry**: "*Electric Vehicle Technology Explained*", Wiley, 2003.

Subject Name & Code	**Optoelectronic Materials and Devices – EC 837**
No. of Teaching Hours : 52	**Credits : 4:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 50**

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

1. Acquire knowledge on the basics of solid state physics.
2. Design display devices and lasers.
3. Design an optoelectronic detection devices and modulators.
4. Design an optoelectronic modulators and optical Switching and Logic Devices.
5. Design an optoelectronic integrated circuits.
6. Work effectively as a member or a leader in teams to implement assigned tasks related to advanced topics.

UNIT 1

Elements of Light and Solid State Physics: Wave nature of light, Polarization, Interference, Diffraction, Light Source, review of Quantum Mechanical concept, Review of Solid State Physics, Review of Semiconductor Physics and Semiconductor Junction Device.

10Hours

UNIT 2

Display Devices and Lasers: Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, OpticalFeedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, laser applications.

12 Hours

UNIT 3

Optical Detection Devices: Photo detector, Thermal detector, Photo Devices, Photo Conductors, Photo diodes, Detector Performance.

10Hours

UNIT 4: Optoelectronic Modulator

Introduction, Analog and Digital Modulation, Electro-optic modulators, Magneto Optic Devices, Acoustoptic devices, Optical, Switching and Logic Devices.

10Hours

UNIT 5: Optoelectronic Integrated Circuits

Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices.

10Hours

References

1. **Pallab Bhattacharya:** "*Semiconductor Opto Electronic Devices*", 3rd edition Prentice Hall of India Pvt. Ltd., New Delhi, 2006.
2. **Jasprit Singh**: "*Opto Electronics – As Introduction to Materials and Devices*", 3rd edition, McGraw –Hill International Edition, 1998.
3. **S C Gupta**: "*Opto Electronic Devices and Systems*, 2nd revised edition, Prentice Hal of India, 2005.
4. **J. Wilson and J.Haukes**: "*Opto Electronics–An Introduction*"3rd edition, Prentice Hall, 1995.

Subject Name & Code	**Project Phase II– EC 84P**
No. of Teaching Hours	**Credits : 0:0:7 L-T-P**
CIE Marks: 70	**SEE Marks: 30**

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**	

Subject Name & Code	**Publication/Internship/Industry Course/Certified online course – EC 85P**
No. of Teaching Hours	**Credits : 0:0:2 L-T-P**
CIE Marks: 50	**SEE Marks:**