COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

DIAMOND JUBILEE
(1956 - 2016)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

Under Choice Based Credit System

(For the students admitted during 2019 - 2020 and onwards)

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COIMBATORE INSTITUTE OF TECHNOLOGY

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VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The Mission of the CIT institute is to impart high quality education and training to its students to make them world-class Engineers with a foresight to the changes and problems and pioneers to offer innovative solutions to benefit the nation and the world at large.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

VISION AND MISSION OF THE DEPARTMENT

VISION

The Vision of the department is to impart knowledge in the field of Electronics and Communication Engineering so as to nurture excellence in students, mould their capability to meet current and impending challenges and ignite aspirations to become innovators and entrepreneurs, thereby benefit the nation and world.

MISSION

M1 : To impart high quality education and training to the students in the field of Electronics and Communication Engineering

M2 : To promote creation and dissemination of knowledge

M3 : To equip the students with right aptitude and attitude for continuous learning

M4 : To provide a framework for collaborative research with industries leading to innovation.

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B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Program Educational Objectives are designed based on the Department Mission

PEO1 The graduates will exhibit knowledge in Mathematics, Engineering fundamentals, Electronics and Communication Engineering and related fields for professional achievement in industry and organizations

PEO2 The graduates will be able to identify, analyze and apply engineering concepts for design of Electronics and Communication Systems and demonstrate multidisciplinary expertise to meet contemporary requirements

PEO3 The graduates will be able to function with leadership qualities, team spirit, managerial skills, attitude and ethics needed for successful career and entrepreneurship

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B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

(POs & PSOs)

Students in the Department of Electronics and Communication Engineering program at the time of their graduation should be in possession of :

PO1 : knowledge in mathematics, science, and engineering fundamentals to solve complex problems in the domain of Electronics and Communication engineering

PO2 : identify, formulate and analyze complex engineering problems in real world using principles of science and engineering for conceptualizing engineering models

PO3 : design solutions for complex engineering problems and design system components for a given specification with appropriate consideration for the public health and safety, economic, political, societal and environmental considerations

PO4 : apply appropriate techniques and tools, design, conduct experiments, analyze and interpret data to demonstrate and view things in a broader perspective either individually or in group(s).

PO5 : apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 : introducing new competitive features in electronic hardware and software systems on behalf of human synthesize complex electronic hardware and software systems for human needs

PO7 : to understand and relate the effect of engineering solutions materialistically ,economically and socially

PO8 : understand and commit to professional ethics with social responsibilities and standard engineering practices

PO9 : ability to work effectively as both an individual and in diverse teams on multidisciplinary environments to accomplish a common goal

PO10 : communicate effectively on engineering activities with the engineering society for the design and preparation of documentation and reports

PO11 : acquire knowledge of contemporary issues and recognize the need for lifelong learning

PO12 : apply knowledge of engineering and management principles in multidisciplinary environment and projects

PSO1 : design and develop models for signal processing and communication systems

PSO2 : design, develop and test electronic and embedded systems for real time applications

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B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

CHOICE BASED CREDIT SYSTEM

Curriculum from the academic year 2019-2020 onwards

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	Category
19ECM31	Matrices, Linear Algebra and Numerical Methods	3	1	0	4	BSC
19EC31	Digital Electronics	3	1	0	4	PCC
19EC32	Analog Electronics	3	0	0	3	PCC
19EC33	Signals and Systems	3	1	0	4	PCC
19EC34	Computer Architecture and Organization	3	0	0	3	PCC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HSC
19ECL35	Digital Electronics Laboratory	0	0	2	1	PCC
19ECL36	Analog Electronics Laboratory	0	0	2	1	PCC
	One Credit Course - Elective I				1	EEC
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

*Pass is required not accounted for GPA

Semester IV

Course Code	Course Name	L	T	P	C	Category
19EC41	Probability and Stochastic Process	3	1	0	4	PCC
19EC42	Principles of Communication	3	1	0	4	PCC
19EC43	Microcontroller Based Systems	3	1	0	4	PCC
19EC44	Linear Integrated Circuits	3	0	0	3	PCC
19EC45	Electromagnetic Fields and Waveguides	3	0	0	3	PCC
19ECL46	Microcontrollers Laboratory	0	0	2	1	PCC
19ECL47	Linear Integrated Circuits Laboratory	0	0	2	1	PCC
	One Credit Course - Elective II				1	EEC
19HOC41	Communication Skills for Engineers -II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

*Pass is required not accounted for GPA

Semester V

Course Code	Course Name	L	T	P	C	Category
19EC51	Control Systems	3	0	0	3	PCC
19EC52	Digital Signal Processing	3	0	0	3	PCC
19EC53	Embedded Systems and IoT	3	0	0	3	PCC
19EC54	Antennas and Wave Propagation	3	0	0	3	PCC
	Elective - I	3	0	0	3	PEC
	Elective - II	3	0	0	3	PEC/OEC
19ECL55	Signal Processing Laboratory	0	0	2	1	PCC
19ECL56	Embedded Systems and IoT Laboratory	0	0	2	1	PCC
	One Credit Course - Elective III	0	0	2	1	EEC
19EC66	Mini Project				-	EEC
19INT51	Internship - I*				1	EEC
19HOC51	Employability and Personality Development Skills- I**	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

* Internship / Project to be completed during 4th semester vacation

** Pass is required not accounted for GPA

Semester VI

Course Code	Course Name	L	T	P	C	Category
19EC61	VLSI Design	4	0	0	4	PCC
19EC62	Digital Communication	3	0	0	3	PCC
19EC63	Data Communication Networks	3	0	0	3	PCC
	Elective - III	3	0	0	3	PEC
	Elective - IV	3	0	0	3	PEC/OEC
19ECL64	VLSI Design Laboratory	0	0	2	1	PCC
19ECL65	Analog and Digital Communication Laboratory	0	0	2	1	PCC
	One Credit Course - Elective IV	1	0	0	1	EEC
19EC66	Mini Project	0	0	6	3	EEC
19INT61	Internship - II*				1	EEC
19HOC61	Employability And Personality Development Skills - II**	0	0	2	1	EEC
	TOTAL CREDITS				**24**	

* Internship to be completed during 5th semester vacation

** Pass is required not accounted for GPA

Semester VII

Course Code	Course Name	L	T	P	C	Category
19EC71	Digital Image Processing	4	0	0	4	PCC
19EC72	Microwave Engineering and Optical Communication	4	0	0	4	PCC
19EC73	Wireless Communication and Networks	3	0	0	3	PCC
	Elective - V	3	0	0	3	PEC
	Elective - VI	3	0	0	3	PEC
19ECL74	Wireless Communication and Networking Laboratory	0	0	2	1	PCC
19ECL75	High Frequency Laboratory	0	0	2	1	PCC
19EC76	Project Phase I	0	0	6	3	EEC
	TOTAL CREDITS				**22**	

SEMESTER VIII

Course Code	Course Name	L	T	P	C	Category
	Elective -VII	3	0	0	3	PEC
	Elective -VIII	3	0	0	3	PEC
19EC81	Project Phase II	0	0	10	5	EEC
	TOTAL CREDITS				**11**	

TOTAL CREDITS : 165 (4 year B.E ECE)

TOTAL CREDITS : 129* (Lateral-B.E ECE)

*125 credits-from 3rd to 8th semester,

4 credits-Bridge Courses (Engineering Mathematics-2 Credits & Physical Sciences -2 Credits)

Category; BSC - Basic Sciences Course, HSC- Humanities and Social Sciences Course, ESC-Engineering Sciences Course, PCC -Professional Core Course, PEC- Professional Elective Course, OEC-Open Elective Course, EEC -Employability Enhancement Course

LIST OF PROFESSIONAL ELECTIVES

COMMUNICATION & SIGNAL PROCESSING

S. No.	Course Code	Course Name	L	T	P	C
1	19ECE01	Multimedia Compression and Communication	3	0	0	3
2	19ECE02	Digital Switching and Transmission	3	0	0	3
3	19ECE03	Introduction to Machine Learning	3	0	0	3
4	19ECE04	Signal Processing Using Python	3	0	0	3
5	19ECE05	Advanced Digital Signal Processing	3	0	0	3
6	19ECE06	Speech Signal Processing	3	0	0	3
7	19ECE07	Wearable Systems	3	0	0	3
8	19ECE08	Adaptive Signal Processing	3	0	0	3
9	19ECE09	Information Theory and Coding	3	0	0	3
10	19ECE10	Communication System Design	3	0	0	3
11	19ECE11	Overview of Industry 4.0	3	0	0	3
12	19ECE12	Cryptography and Network Security	3	0	0	3
13	19ECE13	Parallel and Distributed Processing	3	0	0	3
14	19ECE14	Optical Communication Networks	3	0	0	3
15	19ECE15	Soft Computing and Applications	3	0	0	3
16	19ECE16	Cognitive Radio Communication Systems	3	0	0	3
17	19ECE17	Next Generation Networks	3	0	0	3
18	19ECE18	Wireless Adhoc and Sensor Networks	3	0	0	3
19	19ECE19	Wireless Networks and Standards	3	0	0	3
20	19ECE20	5G Networks	3	0	0	3
21	19ECE21	Network Routing and Infrastructure Management	3	0	0	3
22	19ECE22	Radar and Navigational Aids	3	0	0	3
23	19ECE23	Satellite Communication	3	0	0	3

EMBEDDED SYSTEMS

S. No.	Course Code	Course Name	L	T	P	C
1	19ECE24	Data Structures and Algorithms	3	0	0	3
2	19ECE25	Operating Systems	3	0	0	3
3	19ECE26	Real Time Applications Using Python	3	0	0	3
4	19ECE27	Design Fundamentals of Electric and Hybrid Vehicles	3	0	0	3
5	19ECE28	Automotive Electronics	3	0	0	3
6	19ECE29	Advanced Processor Architectures	3	0	0	3
7	19ECE30	IoT Based System Design	3	0	0	3
8	19ECE31	Real Time Operating Systems	3	0	0	3
9	19ECE32	Robotics	3	0	0	3
10	19ECE33	Real Time Controllers	3	0	0	3
11	19ECE34	Real Time Microcomputer Systems	3	0	0	3

ELECTRONICS & VLSI

S. No.	Course Code	Course Name	L	T	P	C
1	19ECE35	Biomedical Instrumentation	3	0	0	3
2	19ECE36	Power Electronics	3	0	0	3
3	19ECE37	Sensors and Transducers	3	0	0	3
4	19ECE38	Biomedical Transducers and Biosensors	3	0	0	3
5	19ECE39	Nano Electronics	3	0	0	3
6	19ECE40	Nano Sensors and Devices	3	0	0	3
7	19ECE41	Verilog HDL	3	0	0	3
8	19ECE42	HDL Based System Design	3	0	0	3
9	19ECE43	Introduction to Miniaturization Technologies	3	0	0	3
10	19ECE44	Mems	3	0	0	3
11	19ECE45	VLSI Process Technology	3	0	0	3
12	19ECE46	Low Power VLSI Design	3	0	0	3
13	19ECE47	IC Fabrication Technology	3	0	0	3
14	19ECE48	CMOS Analog IC Design	3	0	0	3

MICROWAVE & RF

S. No.	Course Code	Course Name	L	T	P	C
1	19ECE49	Electromagnetic Radiation Hazards and Safety	3	0	0	3
2	19ECE50	Modern Antennas	3	0	0	3
3	19ECE51	Advanced Antenna Technology	3	0	0	3
4	19ECE52	Electromagnetic Interference and Compatibility	3	0	0	3
5	19ECE53	RF Microelectronics	3	0	0	3

LIST OF ONE CREDIT COURSES

S. No.	Course Code	Title of the Course	Group
1	19ECOC01	Basics of Python	I
2	19ECOC02	Quantitative Aptitude for Engineers/ Verbal Aptitude for Engineers	III
3	19ECOC03	Problem Solving with Algorithms and Data Structures	I
4	19ECOC04	Programming in C: A Practical Approach	I
5	19ECOC05	Programming in C++	I
6	19ECOC06	Web Designing and Java	I
7	19ECOC07	Virtual Instrumentation	I
8	19ECOC08	Internet of Things : A Hands-on Approach	I
9	19ECOC09	Machine Learning Algorithms Using Python	I
10	19ECOC10	Programming in Scilab	I
11	19ECOC11	PCB Design and Fabrication	II
12	19ECOC12	Drone - Design & Development	II
13	19ECOC13	Lora Technology	II
14	19ECOC14	Application Design Using Raspberry PI & Python	II
15	19ECOC15	Internet of Things (IoT) Communication Protocols	II
16	19ECOC16	Communication Skills for Engineers	III
17	19ECOC17	Entrepreneurship and Management	III
18	19ECOC18	Professional Skills for Engineers	III
19	19ECOC19	Leadership and Management Skills for Engineers	III
20	19ECOC20	Innovation Management	III
21	19ECOC21	Project Management	III
22	19ECOC22	HMS foundation course on Mobile App Development	II
23	19ECOC23	Baseband Communication - Signal generation and analysis	II
24	19ECOC24	RF Measurement Laboratory	II
25		NPTEL COURSES	IV

GROUP	GROUP NAME
I	PROGRAMMING COURSES
II	INDUSTRY COLLABORATED COURSES
III	SOFT SKILLS DEVELOPMENT COURSES
IV	NPTEL COURSES

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LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CEOE01	Town Planning and Architecture	3	0	0	3	All Branches
19CEOE02	Climate Change and Adaptation	3	0	0	3	All Branches
19CEOE03	Metro Systems and Engineering	3	0	0	3	All Branches
19CEOE04	Renewable Energy Sources	3	0	0	3	All Branches
19CEOE05	Principles of Sustainable Development	3	0	0	3	All Branches
19CEOE06	Disaster Management	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19MEOE01	Design of Experiments	3	0	0	3	All branches
19MEOE02	Engineering Optimization	3	0	0	3	All branches
19MEOE03	Engineering Polymers, Composites and Allied Manufacturing Processes	3	0	0	3	Mechanical Chemical & Civil
19MEOE04	Industrial Robotics	3	0	0	3	Mechanical EEE and ECE
19MEOE05	Business Process Re-engineering	3	0	0	3	All branches
19MEOE06	Engineering Economics and Financial Management	3	0	0	3	All branches

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
19EEOE02	Solar and Wind Energy Systems	3	0	0	3	ECE, Mech, Chemical
19EEOE03	Electrical Safety Procedures and Management	3	0	0	3	All Branches
19EEOE04	Energy Efficient Illumination Systems	3	0	0	3	All Branches
19EEOE05	Electric Vehicle Technology	3	0	0	3	All Branches except Civil & Chemical
19EEOE06	Energy Efficiency in Thermal and Electrical Utilities	3	0	0	3	EEE & Mechanical

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19ECEOE01	Signal Processing and its Applications	3	0	0	3	Chemical, Mechanical & Civil
19ECEOE02	Smart Sensors and IoT	3	0	0	3	All Branches
19ECEOE03	Consumer Electronics	3	0	0	3	Mechanical & Civil
19ECEOE04	Robotics	3	0	0	3	Mechanical, CSE & IT
19ECEOE05	Information Theory and Coding Techniques	3	0	0	3	All Branches
19ECEOE06	Wireless Sensor Networks	3	0	0	3	All Branches
19ECEOE07	Automotive Embedded Systems	3	0	0	3	All Branches
19ECEOE08	5G Technologies and Applications	3	0	0	3	All Branches
19ECEOE09	Vehicular Communication	3	0	0	3	All Branches
19ECEOE010	Sensing for Automotive Systems	3	0	0	3	All Branches

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CSOE01	Customer Relationship Management	3	0	0	3	All Branches
19CSOE02	Fundamentals of Software Engineering	3	0	0	3	All Branches
19CSOE03	Internet Programming	3	0	0	3	All Branches
19CSOE04	Introduction to Data Warehousing and Data Mining	3	0	0	3	All Branches
19CSOE05	Introduction to Embedded Systems	3	0	0	3	All Branches

DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code	Course Name	L	T	P	C	Eligible Branches
19ITOE01	Digital Computer Basics	3	0	0	3	Civil, Mech, Chem
19ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE06	Introduction to Human Computer Interaction	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE07	Enterprise Resource Planning Concepts	3	0	0	3	EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
19CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
19CHOE03	Green Technology	3	0	0	3	All Branches
19CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
19CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches
19CHOE06	Nanomaterial Synthesis and Characterization Laboratory	0	0	6	3	All Branches
19CHOE07	Multivariate Statistics Laboratory	0	0	6	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19MOE01	Graph Theory & its Applications	3	0	0	3	All Branches
19MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
19MOE03	Linear and Non - Linear Programming	3	0	0	3	All Branches
19MOE04	Probability and Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	All Branches except IT
19POE02	Physics and Technology of Thin Films	3	0	0	3	Mechanical, EEE, Chemical & ECE
19POE03	Solar Cell Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
19POE04	Advanced Material Processing Technologies	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
19COE01	Medical Nanotechnology	3	0	0	3	Chemical
19COE02	Advanced Drug Delivery Systems	3	0	0	3	Chemical
19COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
19COE04	Nanocomposites	3	0	0	3	Mechanical, Chemical & Civil
19COE05	Biorefinery	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
19HOE01	Principles of Management	3	0	0	3	Common to all branches
19HOE02	Current Trends in Indian Economy	3	0	0	3	Common to all branches
19HOE03	Monetary Economics	3	0	0	3	Common to all branches
19HOE04	English for Academic Purposes	3	0	0	3	Common to all branches
19HOE05	English for Competitive Exams	3	0	0	3	Common to all branches
19HOE06	Life and Literature	3	0	0	3	Common to all branches

19ECM31 - MATRICES, LINEAR ALGEBRA AND NUMERICAL METHODS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Solve matrix problems in finding Eigen values and Eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.

CO2 : introduce the basic notions of groups, rings, fields which will then be used to solve related problems.

CO3 : understand the concepts of vector space, linear transformations and diagonalization.

CO4 : apply the concept of inner product spaces in orthogonalization.

CO5 : demonstrate accurate and efficient use of Numerical methods concepts to solve Engineering problems

MATRICES

Characteristic equation -Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors (without proof) - Cayley-Hamilton theorem (without proof)-Diagonalization of matrices using orthogonal transformation -Quadratic Form: Nature- Reduction to canonical form by orthogonal transformation.					**(9)**

VECTOR SPACES

Vector spaces and Subspaces-Null spaces, column spaces, Linear Transformations-Linearly Independent sets; Basis-Coordinate systems-The dimension of a vector space-Rank and Nullity-Change of Basis.					**(9)**

LINEAR TRANSFORMATION, DIAGONALIZATION AND INNER PRODUCT SPACES

Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of linear transformations - Eigenvalues and Eigenvectors - Diagonalizability.

Inner product, Length and orthogonality-Orthogonal sets-Orthogonal Projections-The Gram-Schmidt process-Least-Squares problems.					**(9)**

NUMERICAL METHODS-I

Solution of algebraic and transcedental equation by Newton Raphson method-Gauss Elimination method, Gauss Seidel method-Numerical solution of first order ODE: Modified Euler's method- Runge- kutta fourth order method-Milne's predictor and corrector method.					**(9)**

NUMERICAL METHODS-II

Classification of second order Partial differential equations-Finite difference approximation-Graphical representation of partial quotients-Solutions of Laplace equations by Leibmann's iteration process-Solution of Poisson equation by explicit method-Solution of parabolic equation -Bender-Schmidt method-Crank Nicholson method.					**(9)**

TOTAL : 60

TEXT BOOKS :

1. David C.Lay, "Linear Algebra and its Applications", 5th Edition, Pearson Education, 2015.

2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES

1. *Burden, R.L. and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.*

2. *James, G. Advanced Modern Engineering Mathematics, Pearson Education, 2007.*

3. *Kolman, B. Hill, D.R., Introductory Linear Algebra, Pearson Education, New Delhi, First Reprint, 2009.*

4. *Kumaresan, S., Linear Algebra - A Geometric Approach, Prentice - Hall of India, New Delhi, Reprint, 2010.*

5. *Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014*

19EC31 - DIGITAL ELECTRONICS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Determine the simplified digital logic circuits using the Boolean Algebra, Karnaugh Map and Quine Mc Cluskey methods and implementing with universal Gates*

CO2 : *Design a combinational logic circuit using adders/subtractors, encoders/decoders, multiplexer/demultiplexers and programmable logic circuits for arithmetic and logical operations.*

CO3 : *Design synchronous sequential logic circuits using different flip-flops for counters and shift registers.*

CO4 : *Design asynchronous sequential logic circuits with Race and Hazard free circuits.*

CO5 : *Construct programs for combinational and sequential logic circuit using VHDL code.*

MINIMIZATION TECHNIQUES AND BOOLEAN FUNCTIONS

Review of Binary Number Systems- Binary codes -Boolean Algebra and Functions- Canonical and standard forms - Digital Logic gates- Karnaugh Map-Product of Sums Simplification - Sum of Products Simplification - Don't care conditions - NAND and NOR implementation - Quine-McCluskey method. **(9)**

COMBINATIONAL LOGIC CIRCUITS

Combinational Circuits-Analysis Procedure- Design Procedure- Code converters- Binary Adder -Subtractor- BCD adder - Magnitude Comparator -Decoders - Encoders -Code convertors - Multiplexers - Demultiplexers- Design of Combinational Logic Circuits using decoders, multiplexers and demultiplexers - implementation of combinational circuits using ROM - PLDs: Programmable Array Logic- Programmable Logic Array. **(9)**

SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS

Sequential Circuits-Latches-Flip-Flops - Types - Master Slave configuration - Characteristic table and equation -Flip Flop excitation tables - Analysis of clocked sequential circuits : Concepts of state equations: State diagrams, State table, State reduction, State Assignment - Mealy/Moore models - Design of synchronous sequential circuits- Shift registers -Universal Shift registers- synchronous counters: Binary counter-BCD Counter-Ripple counters- Ring Counter- Johnson's Counter - Modulo-N counters. **(9)**

ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS

Block diagram -Analysis and Procedure-Circuit with Latch-Design Procedure-Reduction of state and flow table-Hazards. **(9)**

VHDL

Introduction to Hardware Description Language and VHDL - Design flow - Entity, architecture, process, configuration and package declarations - Signals, data objects and types- Operators and expressions - Concurrent and sequential statements - Behavioral modeling -Data flow modeling -structural modeling - VHDL code for Combinational circuits, Flip Flops, Registers and Counters. **(9)**

TOTAL : 60

TEXT BOOKS

1. *M. Morris Mano, "Digital Design: with a Introduction to the Verilog Hdl ", Pearson Education, 5th Edition, 2014.*

2. *Stephen Brown and ZvonkoVranesic, "Fundamentals of Digital Logic with VHDL Design", Tata McGraw Hill Education Pvt.Ltd., 3rd Edition, 2017.*

REFERENCES

1. Tocci R J and Widmer N S, "Digital Systems - Principles and Applications", Prentice Hall of India, New Delhi,11th Edition, 2010.

2. Charles H Roth, "Fundamentals of Logic Design", Thomas Publication Company, 7th Edition, 2011.

3. J.Basker, "A VHDL Primer", Addison Wesley, New Delhi, 3rd Edition, 2015.

4. John.F.Wakerly,"Digital Design Principles and Practices", Pearson Education,4th Edition, 2006.

5. Thomas L.Floyd, "Digital Fundamentals", Pearson Education, Tenth Edition, 2011(Paperback)

19EC32 - ANALOG ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Examine semiconductor diode characteristics and design rectifiers, voltage regulator and wave shaping circuits.*

CO2 : *Design DC biasing circuits for transistors and calculate their stability factors*

CO3 : *Design and analyze BJT amplifiers*

CO4 : *Design and analyze FET amplifiers*

CO5 : *i) Construct the different classes of power amplifiers and calculate their efficiencies*

      ii) Design and analyze BJT and FET feedback amplifiers

SEMICONDUCTOR DIODES

Semiconductor diode - Resistance levels - Diode equivalent circuits - Transition and Diffusion Capacitance - Reverse recovery time - Load line Analysis - Half Wave and Full wave Rectifier - Clippers and Clampers - Voltage Multiplier - Zener Diode - Voltage regulator using Zener diode. **(10)**

DC BIASING

DC load line - Operating point - Design of BJT biasing circuits: Fixed bias configuration, Emitter bias configuration, Voltage divider bias configuration- Emitter follower configuration - Common base configuration - Bias stabilization - Stability factors - Design of FET & MOSFET biasing circuits: Fixed bias configuration - Self bias configuration - Voltage divider biasing - Common gate configuration - Depletion Type MOSFETs - Enhancement Type MOSFETs. **(12)**

BJT AMPLIFIERS

AC load line -Transistor hybrid equivalent model - Common Emitter circuit analysis - CE with un-bypassed R_E - Miller effect - Low & High Frequency response of CE amplifier - Capacitor coupled two stage CE amplifier-Direct coupled two stage circuits-Two stage circuit with emitter follower output-Cascode amplifiers. **(7)**

FET AMPLIFIERS

AC load line - FET AC equivalent circuit - Common Source circuit analysis- CS with un-bypassed R_S - Low & High Frequency response of CS amplifier **(7)**

POWER AMPLIFIERS AND FEEDBACK AMPLIFIERS

Series-Fed Class A Amplifier - Transformer coupled class A Amplifier, class B and class AB power amplifier- Amplifier distortion - Power transistor heat sinking - Class C amplifiers.

Feedback concepts - Feedback connection types - Practical feedback circuits - Current series and Current shunt feedback using BJTs - Voltage series and Voltage shunt feedback using FETs. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Robert L. Boylestead and Louis Nasheresky "Electron Devices and Circuits: Theory and Practice", Prentice Hall of India, 11th Edition, 2013.*

2. *David A. Bell, "Electronic Devices and Circuits", Prentice Hall of India, 5th Edition, 2010.*

REFERENCES

1.	Millman and Halkias.C,"Integrated Electronics", Tata McGraw Hill, 2nd Edition, 2010.

2.	 Thomas.L.Floyd, "Electronic Devices: Conventional Current version", Pearson, 9th Edition, 2015.

3.	Adel .S. Sedra, Kenneth C. Smith, Micro Electronic circuits, 7th Edition, Oxford University Press, 2014.

4.	B. Visvesvara Rao, K. Raja Rajeswari, P. Chalam Raju Pantulu and K.Bhaskara Rama, "Electronic Circuit Analysis", Pearson, 1st Edition, 2012.

5.	Allen Mottershed, "Electronic Device and Cirucits : An Introduction", Prentice Hall India Learning Pvt. Ltd., 1973.

19EC33 - SIGNALS AND SYSTEMS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Express continuous time & discrete time signals using standard functions, represent continuous and discrete time systems and compute the response of LTI systems using linear convolution*

CO2 : *Use Fourier Transform to analyze and sketch the spectrum of continuous time signals and determine the frequency response of Linear Time Invariant continuous time systems*

CO3 : *Illustrate the sampling of low pass signals in time domain and Fourier Transform approach*

CO4 : *Use Fourier Transform to analyze and sketch the spectrum of discrete time signals and determine the frequency response of Linear Time Invariant discrete time systems*

CO5 : *Solve differential and difference equations and determine the response of Linear Time Invariant systems using Laplace & z transform.*

INTRODUCTION TO SIGNALS AND SYSTEMS

Basic continuous time signals and discrete time signals - Representation of signals in terms of impulses - Continuous time systems - Discrete time systems - Properties of systems - Linear Time Invariant systems - Convolution Integral - Convolution Sum. **(12)**

FOURIER ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS

Continuous Time Fourier Transform - Properties of Fourier Transform - Response of Continuous time systems to complex exponentials - Continuous time system representation by differential equations - Frequency response of systems characterized by differential equations. **(8)**

SAMPLING

Representation of continuous time signals by samples - Sampling theorem for Low pass signals - Band pass signal sampling - Reconstruction from samples using interpolation - Effect of under sampling - Aliasing error. **(7)**

FOURIER ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS

Introduction to Discrete Time Fourier Series - Fourier Transform of Discrete time aperiodic signals - Properties of Discrete Time Fourier Transform - Response of discrete time systems to complex exponentials - Discrete time system representation by difference equation - Frequency response of systems characterized by difference equations. **(8)**

LAPLACE AND z TRANSFORM

Laplace Transform and Inverse Laplace transform - RoC for Laplace transform - Properties of Laplace transform - Analysis and characterization of Continuous time LTI system using Laplace Transform.

Z-Transform and Inverse Z-Transform using partial fractions - Properties of z transform - Analysis and characterization of Discrete time LTI system using z-Transform. **(10)**

TOTAL : 60

TEXT BOOKS

1. *Alan V. Oppenheim, Alan S. Willsky, "Signals and Systems", Pearson Education, 2nd Edition, 2013.*
2. *Krishnaveni.V and Rajeswari. A, "Signals and Systems", Wiley India Pvt. Ltd, 1st Edition, Reprint 2019.*

REFERENCES

1. Haykin. S and Barry Van Veen, "Signals and Systems", John Wiley and Sons, 2nd Edition, 2007.

2. Hsu.H.P and Rakesh Ranjan, "Signals and Systems", Schaums's Outlines, Tata Mc Graw Hill, 2nd Edition, 2008.

3. Sanjit Kumar Mitra , "Signals and Systems", Oxford University Press, 2015

4. Lathi. B. P, "Linear Systems and Signals", Oxford University Press, 3rd Edition 2018.

5. Ronald E. Ziemer, William H. Transter and Ronald. D. Fanmin, "Signals and Systems - Continuous and Discrete", Pearson Higher Education, 4th Edition, 1998.

19EC34 - COMPUTER ARCHITECTURE AND ORGANIZATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the concepts of computer architecture, Instruction set design and addressing mode.*

CO2 : *Illustrate the concepts of CPU design with fixed point and floating point arithmetic.*

CO3 : *Interpret the concepts of control design using hardwired and micro programmed control.*

CO4 : *Exemplify the functions of memory subsystems to integrate with CPU.*

CO5 : *Illustrate the methodologies for interfacing I/O devices and explain the concepts of parallelism and concurrency in computers.*

CPU ARCHITECTURE AND INSTRUCTION SET PRINCIPLES

Computer Functional units -Processor role and design goals-Processor Design Process- Datapath and Control Unit Organization - Instruction set design - Instruction Types and operations - Addressing Modes. **(9)**

CPU DESIGN AND DATA PATH

Arithmetic and Logic Unit - Shifters - ALU design - Fixed point datapath- Floating point datapath -Fixed Point Arithmetic: Booth's Multiplication algorithm -Non-Restoring Division Algorithm - Floating Point Arithmetic. **(9)**

INSTRUCTION PROCESSING AND CONTROL UNIT

Basic Processing concepts-Instruction Cycle - Single bus processor - Hardwired Control - Micro programmed Control. **(9)**

MEMORY ORGANIZATION

Memory Parameters-Classification of Memory-ROM & RAM subsystem design-Memory Allocation-Cache and Virtual Memory-Associative memory. **(9)**

SYSTEM ORGANIZATION

Accessing I/O devices- Interrupt Handling - Bus Arbitration Techniques- Bus concepts- Interface circuits and I/O Controllers-Parallelism & Pipelining- Concept of Superscalar architecture, Vector Computing and Array Processing. **(9)**

TOTAL : 45

TEXT BOOKS

1. *B.Govindarajalu, "Computer architecture and Organisation: Design principles and Applications", Tata McGraw Hill Education, 2nd Edition, 2010.*

2. *John P.Hayes, "Computer architecture and Organization", Tata McGraw - Hill, 3rd Edition, 2012.*

REFERENCES

1. *P.Pal Chaudhuri, "Computer organization and design", Prentice Hall of India, New Delhi, 3rd Edition, 2008.*

2. *William Stallings, "Computer Organization and Architecture: Designing for Performance" ,Prentice Hall, 9thEdition, 2012.*

3. *Kai Hwang and Faye A Briggs, "Computer Architecture and Parallel Processing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.*

4. *Morris Mano, "Computer System Architecture", Prentice Hall of India, 3rd Edition, 2007.*

5. *Nicholas Carter, "Computer Architecture", Tata McGraw Hill Education, 2008.*

19HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the principles of karma yoga and functioning of mind and consciousness.*

CO2 : *Hypothesize the evolution of Universe and living beings in a global and societal context*

CO3 : *Infer the principles of Yoga to practice it and know the value of health.*

CO4 : *Interpret the philosophy of introspection procedures for better living*

CO5 : *Assess, take personal responsibility and follow professional ethics for sustained growth in career and life*

LIFE FORCE, MIND AND CONCIOUSNESS

Science of Creativity and Personality Development - Objectives - Principles of Karma Yoga - Duty Consciousness - Communism and Capitalism - Law of Nature - Life Force - Origin - Potentiality of the Life Force - Premordial State - Wave Theory - Consciousness - Pancha Thanmatras - Secret of Revelations - Mind - Biomagnetism - Physical Transformation of Biomagnetism   **(7)**

EVOLUTION OF THE UNIVERSE AND LIVING BEINGS

Evolution of the Universe: Creation Theory - Evolution Theory - Theory of Permanence - Theory of Mithya - Evolution of Living Beings: Absolute Space and Force - Plants Experience Pain - Two Eyes and Two Ears - Seven Constituent Layers in the Body.   **(5)**

YOGA AND ITS BENEFITS

Simple and Safe Yoga - Upa Yoga Practices: Yoga for Peace - Yoga for Health - Yoga for Joy - Yoga for Love - Yoga for Well-being - Yoga for Success. Physical Exercise - Meditation - Seven Centers of Meditation - Benefits - Effect of Good Vibrations - Cause and Effect System.   **(6)**

INTROSPECTION

Attachment, Detachment and Moderation in Enjoyment - Imaginary Expectations - Harmony in Life: Self, Family, Society and Nature - Introspection: Analysis of Thought, Moralization of Desire, Neutralization of Anger, Eradication of Worries and Self Realization.   **(6)**

HUMAN VALUES

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Virtues - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - Commitment - Empathy - Self Confidence - Challenges in Work Place - Impact of cyberspace on individuals.   **(6)**

TOTAL : 30

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications, IV Edition, 2009.*

2. *R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011.*

REFERENCES

1. *Sadhguru, "Body the Greatest Gadget and Mind is your Business", Diamond Pocket Books Pvt. Ltd, Isha Foundations, 2013.*

2. Swami Vivekananda and Swami Nikhilananda, "Karma Yoga and Bhakti Yoga", II Edition, Ramakrishna Vivekananda Publications, 2008.

3. Henry Dreyfuss, "The Measure of Man and Woman: Human Factors in Design", John Wiley and Sons Publications, 2012.

4. Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", IV Edition, McGraw Hill, NewYork, 2005.

5. M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", I Edition, Prentice Hall of India, 2009.

19ECL35 - DIGITAL ELECTRONICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Design, Construct and Simulate combinational logic circuit using Digital ICs*

CO2 : *Design, Construct and Simulate Sequential logic circuit using Digital ICs*

CO3 : *Develop communication skills and capability to work in team*

LIST OF EXPERIMENTS

- Verification of De-Morgans theorem
- Adders and Subtractors
- Four bit binary adder/subtractor and BCD adder
- BCD to Excess 3 converters and Excess 3 code to BCD converters
- Binary to gray code and Gray code to binary converters
- Multiplexers and De-multiplexers
- Encoders and Decoders
- Ripple counter and Modulus counter
- Synchronous Up/Down counter

TOTAL : 30

REFERENCES

1. *Digital Circuits Laboratory Manual prepared by ECE Department, CIT.*

2. *Stephen Brown and Zvonko Vranesic, "Fundamentals of digital logic with VHDL design", Tata McGraw Hill Education Pvt. Ltd., 3rd Edition, 2017.*

19ECL36 - ANALOG ELECTRONICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

C*O1*   :   *Construct and test diode based wave shaping and rectifier circuits*

CO2.   :   i)   *Design and test different types of biasing circuits for given specifications and calculate their stability factors*

ii)   *Design, test and analyze the frequency response of BJT and FET amplifiers with and without feedback*

iii)   *Design and test power amplifiers*

CO3   :   *Develop communication skills and capability to work in teams*

LIST OF EXPERIMENTS

- Wave Shaping Circuits
- Rectifier circuits
- Self Bias and Fixed Bias circuits using BJT
- Voltage divider Bias circuits using BJT and FET
- Common Emitter Amplifier
- Direct coupled and RC Coupled amplifiers
- Current series and Current shunt feedback amplifiers using BJT
- Voltage series and Voltage shunt feedback amplifiers using FET
- Class A , Class B and Class C power amplifiers

TOTAL : 30

REFERENCES

1.   *Laboratory Manual prepared by ECE Department, CIT.*
2.   *M. H. Rashid, "Introduction to PSPICE using ORCAD for Circuits and Electronics", Prentice Hall of India Pvt. Limited, 4th edition, 2015.*

19EC41 - PROBABILITY AND STOCHASTIC PROCESSES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand the basic concepts of probability and discrete random variables*

CO2. : *Understand the concepts of continuous and pairs of random variables and its usage in communication systems*

CO3 : *Understand the moment generating function for families of random variables*

CO4 : *Interpret the usage of stochastic process in communication systems*

CO5 : *Analyze the response of random inputs to linear time invariant systems and to understand the concept of power spectral density of a random sequence*

PROBABILITY AND DISCRETE RANDOM VARIABLES

Probability Axioms - Conditional Probability: Law of Total Probability, Baye's Theorem - Independence.

Discrete Random Variables: Probability Mass Function - Bernoulli, Binomial and Poisson Random Variables - Cumulative Distribution Function - Expectations. **(11)**

CONTINUOUS AND PAIRS OF RANDOM VARIABLES

Continuous Random Variables: Probability Density Function - Uniform, Exponential and Gaussian Random Variables, Expectations. Pairs of Random Variables: Joint Cumulative Distribution Function - Joint Probability Mass Function - Marginal Probability Mass Function - Joint Probability Density Function - Marginal Probability Density Function - Expected Values - Covariance - Correlation - Independent Random Variables. **(11)**

SUMS OF RANDOM VARIABLES

Expected Values of Sums - Probability Density Function of the Sum of Two Random Variables - Moment Generating Function for families of Random Variables - Central Limit Theorem - Applications of Central Limit Theorem **(7)**

STOCHASTIC PROCESSES

Types of Stochastic Processes - Poisson Process, Brownian Motion Process - Expected Value and Correlation - Stationary Processes - Wide Sense Stationary Stochastic Processes - Cross- Correlation - Gaussian Processes. **(8)**

RANDOM SIGNAL PROCESSING

Linear Filtering of Continuous-Time Stochastic Process - Linear Filtering of a Random Sequence - Power Spectral Density of a Continuous -Time Process - Power Spectral Density of a Random Sequence. **(8)**

TOTAL : 60

TEXT BOOKS

1. *Roy D. Yates and David J Goodman, Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers, John Wiley & Sons, New Delhi, 2012.*

2. *T. Veerarajan, "Probability, Statistics and random process", Tata McGraw Hill, Third Edition, 2008.*

REFERENCES

1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.

2. Saeed Ghahramani, Fundamentals of Probability with Stochastic Processes, Prentice Hall, New Jersy, 2014.

3. Sheldon M. Ross, Stochastic Processes, Wiley India Pvt. Ltd, New Delhi, 2008.

4. Athanasios Papoulis and Unnikrishna Pillai S, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill, New Delhi, 2006.

5. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, Wiley, Delhi, 2014.

19EC42 - PRINCIPLES OF COMMUNICATION

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate DSB-FC, DSB-SC, SSB-SC, VSB amplitude modulation techniques & their spectrum, explain the function of DSB-SC and SSB-SC modulators and compare their performances*

CO2: *Illustrate angle modulation techniques & their spectrum, compare their performances, and explain the operating principle of FM transmitter*

CO3 : *Describe the operation of AM & FM receivers, compare & distinguish between their performance characteristics and parameters*

CO4 : *Describe the operation of pulse analog modulation & pulse digital modulation techniques*

CO5 : *Express narrow band noise using I & Q components & estimate the performance of DSB-SC, SSB-SC & FM Receivers systems using Figure of Merit and compute the SNR of PCM and DM systems*

AMPLITUDE MODULATION

Elements of Communication System - Communication Channels - Need for Modulation - Frequency Translation - Types of Amplitude Modulation and their Spectrum - DSB-SC Modulators: Product Modulator, Balanced Modulator - SSB-SC Modulators: Filter Method, Phase Shift Method - AM Transmitters. **(9)**

ANGLE MODULATION

Phase Modulation - Frequency Modulation - Narrow Band FM - Wide Band FM - Frequency Spectrum of FM - Transmission Bandwidth of FM Signals - Direct FM generation: Reactance Modulator - Narrowband FM generation- Indirect FM generation - Pre-Emphasis and De-Emphasis - Armstrong FM Transmitter. **(9)**

AM & FM RECEIVERS

AM Demodulators: Envelope detector, Coherent Detection of DSB-SC, SSB-SC - Costas Receiver - AM Receivers: Super heterodyne.

FM Demodulators: Foster Seeley Discriminator, Ratio Detector, PLL Demodulator- FM Receivers. **(9)**

PULSE MODULATION

Sampling Process - Pulse Amplitude Modulation - Pulse Width Modulation - Pulse Position Modulation - Quantization Process - Uniform and Non-Uniform Quantization - Pulse Code Modulation - Delta Modulation- Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation. **(9)**

NOISE IN CW SYSTEMS

Noise - Narrow Band Noise and its properties - Representation of Narrow Band Noise: In-phase & Quadrature Components, Envelope & Phase Components - Sine Wave Plus Narrowband Noise - Receiver Model - Noise in DSB-SC, SSB-SC & FM Receivers - SNR of PCM and DM systems. **(9)**

TOTAL : 60

TEXT BOOKS

1. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2004.

2. Herbert Taub and Donald L. Schilling, "Principles of communication", McGraw Hill International student Edition, 3rd Edition, 2008.

REFERENCES

1. Wayne Tomasi, "Electronic Communication Systems: Fundamentals Through Advanced", Pearson Education, 5th Edition, 2009.

2. John G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, 2nd Edition, 2015.

3. Kennedy G, "Electronic Communication Systems", Tata McGraw Hill, 4th Edition, 1999.

4. Lathi. B. P, "Communication Systems", BS Publications, 4th Edition, 2004.

5. Hwei P. Hsu,"Schaum's Outlines of Analog and Digital Communication", McGraw Hill, 3rd Edition, 2003.

19EC43 - MICROCONTROLLER BASED SYSTEMS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Interpret the architecture & instruction set of 8051 microcontroller to develop Assembly language programs.

CO2 : Illustrate the application of 8051 microcontroller on chip peripherals to implement the functions of I/O port, timer/ counter, serial port & interrupts.

CO3 : Exemplify the peripheral devices 8255 PPI and LCD display and traffic light controller,8279 for interfacing keyboard and 7 segment display and 8259 PIC for handling multiple interrupts I/O.

CO4 : Integrate memory modules and the I/O devices ADC, DAC, Sensor & RTC with 8051microcontroller for an application and develop Assembly Language Programs.

CO5 : Interpret the programming aspects of Arduino IDE to develop an Arduino based applications.

8051 MICROCONTROLLER

Architecture of 8051 microcontroller - Special Function Registers - I/O Pins, Ports and Circuits - Instruction Set - Addressing Modes - Assembly language Programming. **(9)**

ON-CHIP PERIPHERALS

I/O Port Programming - Timer Registers - Timer Modes - Overflow Flags - Clocking Sources -Timer/ Counter Interrupts - Timer Programming - Baud Rate Generation - Serial Port Register -Modes of Operation - Serial Port Programming- Interrupt Organization - Processing Interrupts - Interrupt Programming. **(9)**

PERIPHERAL DEVICES

Programmable Peripheral Interface (8255) - Keyboard / Display Controller (8279) - Programmable Interrupt Controller (8259) - Case Studies: Traffic Light Control, Interfacing Keyboard, Seven Segment and LCD display - Multiple Interrupt requests. **(9)**

INTERFCAING MEMORY AND I/O DEVICES WITH 8051

External Memory Interface - Interfacing with MAX232 chip for RS232C Communication - ADC and DAC Interface - Measuring voltage, current and frequency - RTC Interfacing - DC Motor Control - Stepper Motor Control. **(9)**

ARDUINO BASED SYSTEM

Arduino functionality - Arduino Board - Arduino IDE - Digital Inputs, Outputs, and Pulse-Width Modulation - In Built functions and libraries for interfacing Sensors and Actuators - Case Studies: Interfacing Relays and Sensors - Temperature monitoring - Distance measurement - Smart home automation system. **(9)**

TOTAL : 60

TEXT BOOKS

1. *Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, "The 8051 Microcontroller and Embedded Systems Using Assembly and C ", 2nd Edition, Pearson Education 2013.*

2. *Kenneth Kenneth J. Ayala, "The 8051 Microcontroller. Architecture, Programming and Applications", 3rd Edition, West publishing company 2014*

REFERENCES

1. *Krishna Kant, "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086,8051, 8096", Prentice Hall of India, 2nd Edition, 2014.*

2. *Soumitra Kumar Mandal "Microprocessors and Microcontrollers Architecture Programming and Interfacing using 8085,8086 & 8051" Tata McGraw Hill Publishing Co Ltd, 1st Edition, 2011.*

3. *Myke Predko, "Programming and Customizing the 8051 Microcontroller", 1st Edition, 2012.*

4. *Manish K Patel, "The 8051 Microcontroller Based Embedded Systems "Tata McGraw Hill Publishing Co Ltd, Ist Edition, 2014.*

5. *Jeremy Blum "Exploring Arduino: Tools and Techniques for Engineering Wizardry" John Wiley and sons , 2nd Edition, 2019.*

WEBSITE REFERENCE

https://www.coursera.org/learn/interface-with-arduino

19EC44 - LINEAR INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret and analyze differential amplifiers with constant current sources, Interpret the characteristics of operational amplifier*

CO2 : *Design and analyze operational amplifier application circuits*

CO3 : *Design and analyze filters & oscillator circuits using operational amplifier*

CO4 : *Analyze and design multivibrators and data converters using linear ICs*

CO5 : *Aapply the concepts of PLL to design frequency multiplier/divider, FSK demodulator and design voltage regulators using ICs*

OPERATIONAL AMPLIFIERS

Differential amplifier - differential amplifier with constant current source - current mirror - Widlar current source- current repeaters -Wilson current source-Building blocks of operational amplifier-I/O stages, gain stage and level translator stage of op-amp - Characteristics of an Ideal Operational Amplifier-Op-amp parameters & characteristics- frequency response - stability - frequency compensation. **(9)**

OP-AMP APPLICATIONS

Linear applications: voltage follower - inverting, non inverting amplifiers-summing, scaling, averaging amplifiers-instrumentation amplifiers- V to I & I to V converters - difference amplifier-integrator-differentiator.

Nonlinear applications: Precision half wave & full wave rectifiers - clipper- clamper - peak detector-sample & hold circuit-log & anti-log amplifiers

Open loop applications: Comparator-zero crossing detector- Schmitt trigger-voltage limiters-window detectors. **(9)**

ACTIVE FILTERS AND OSCILLATORS

Active filters - Sallen-Key filter structure- Design of Butterworth filters: Low pass filter- High pass filter- Band pass filter- Band reject filter - All pass filters - Switched capacitor filters-Design of Oscillators: RC phase shift oscillator- Wien bridge oscillator- LC Oscillators: Hartley oscillator - Colpitts oscillator - Clapp oscillator- Crystal oscillator. **(9)**

MULTIVIBRATORS AND DATA CONVERTERS

Design of Astable Multivibrator & Monostable Multivibrator using Op.Amp -Triangular wave generator-Saw tooth wave generator - IC 555 timer: Functional block diagram and description of Astable & Monostable multivibrators using IC555 - Digital to Analog converters: Binary Weighted Network - R-2R Ladder Network- inverted R-2R ladder network - Analog to Digital converters: Successive Approximation - Counter Type - Dual slope - Flash type converters. **(9)**

PLL AND VOLTAGE REGULATORS

Phased Locked Loop: operating principles-Basic building blocks - Applications: Frequency multiplier/divider - Frequency translator - Frequency synthesizer - FM demodulator - FSK demodulator - Monolithic PLL - Voltage regulators: Fixed voltage regulator-Adjustable voltage regulator - Dual tracking regulator - Switching regulator: self oscillating type switching regulator - IC voltage regulators. **(9)**

TOTAL : 45

TEXT BOOKS

1. Gayakwad Ramakant A, "Op-amps and Linear Integrated Circuits", Pearson Education, 4th Edition, 2015.

2. Roy Choudhury and Shail Jain "Linear Integrated Circuits", New Age International Private Limited, 5th Edition, New Delhi, 2018.

REFERENCES

1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGraw-Hill, 3rd Edition, 2007.

2. K.R.Botkar, "Integrated Circuits", Khanna Publishers, 2nd Edition, 2003.

3. B.Somanathan Nair, "Linear Integrated Circuits, Analysis, Design and Applications", Wiley India Publishers, 1st Edition, 2009.

4. Ron Mancini, "OP AMPs for Everyone", Newnes, An Imprint of Elsevier, 2nd Edition, 2003.

5. Robert F. Coughlin, Frederick F. Driscoll, " Operational Amplifiers and Linear Integrated Circuits", Prentice Hall ,6th Edition, 2001.

19EC45 - ELECTROMAGNETIC FIELDS AND WAVEGUIDES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Describe the concepts of Electrostatic fields with the help of mathematics.

CO2 : Describe the concepts of static Magnetic fields with the help of mathematics.

CO3 : Interpret Maxwell's equations for time varying Electromagnetic fields, determine its parameters for different media, distinguish various polarizations of plane waves and evaluate reflection and transmission coefficients

CO4 : Formulate general solutions for TE, TM & TEM modes of parallel plate and Rectangular waveguides and determine parameters such as frequency, phase constant, velocity, attenuation and associated characteristic impedance for the waveguides.

CO5 : Formulate general solutions for TE, TM & TEM modes of Circular waveguide and determine parameters such as frequency, phase constant, velocity, attenuation and associated characteristic impedance for the waveguide and Q factor of Rectangular Cavity Resonators

ELECTROSTATIC FIELDS

Fundamentals of vector calculus-Introduction to three co-ordinate systems - Introduction to electrostatic fields - Coulomb's Law and field intensity - Electric Field due to Line, Surface and Volume charge distributions - Electric flux density - Gauss's law- Maxwell's equation - Application of Gauss's law - Electric potential - Relationship between E and V- Energy density - Boundary conditions in electrostatic fields - Capacitance of parallel plate-Capacitance of Coaxial cable - Laplace and Poisson's equations.   **(10)**

MAGNETIC FIELDS

Biot-Savart's Law - Ampere's circuital law - Applications - Magnetic flux density and Maxwell's equations - Magnetic -Scalar and Vector potential - Magnetic Torque and Moment - Magnetic Boundary conditions -Magnetic energy - Inductors and Inductances - Energy stored in magnetic field - Energy density.   **(9)**

ELECTROMAGNETIC WAVES

Maxwell's equation - Equation of continuity - Inconsistency of Ampere's law - Wave motion in free space -Uniform plane waves - wave equation for conducting medium - Sinusoidal time variations - Conductors and Dielectrics - Relation between E and H in a uniform plane waves - Reflection by a perfect conductor -Normal and Oblique incidence - Reflection by a Dielectric- Normal and Oblique incidence - Poynting Vector and Theorem.   **(9)**

WAVES AND RECTANGULAR GUIDES

Waves between parallel planes - Transverse Electric waves - Transverse Magnetic waves -characteristics of TM and TE waves - Transverse Electromagnetic waves - Velocities of propagation - Attenuation for TM,TE and TEM waves -Wave impedances. Rectangular guides: Transverse Electric waves in Rectangular guides- Transverse Magnetic waves in Rectangular guides - Impossibility of TEM waves in waveguide.   **(9)**

CIRCULAR GUIDES AND CAVITY RESONATORS

Circular guide: Transverse Electric waves and Transverse Magnetic waves in circular guides - Excitation of various modes - Wave impedances and characteristic impedances - Cavity Resonators - Rectangular cavity resonators - Q factor of rectangular cavity resonator for TE101 mode.   **(8)**

TOTAL : 45

TEXT BOOKS

1. *Mathew.N.O.Sadiku, "Elements of Electromagnetics", Oxford University press, 6th Edition, 2015.*
2. *David K.Cheng , "Field and Wave Electromagnetics", Pearson Education, 2013.*

REFERENCES

1. *William H.Hayt, "Engineering Electromagnetics",Tata McGraw-Hill, 8th Edition, 2012.*
2. *Edward.C.Jordan & Keith.G.Balmain,, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, 2nd Edition, 1995.*
3. *Rajeev Bansal, " Fundamentals of Engineering Electromagnetics", Taylor & Francis, 2018*
4. *Joseph A.Edminister, "Schaum's Outline of Electromagnetics", Tata McGraw-Hill, Fifth Edition, 2018.*
5. *Nathan da, " Engineering Electromagnetics", Springer, third Edition, 2018*

19ECL46 - MICROCONTROLLERS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Develop an 8051 microcontroller Assembly Language Programs using Assembler, KEIL IDE & Proteus Simulator and interface ADC & DAC boards with microcontrollers.*

CO2 : *Demonstrate real time applications using ARDUINO boards*

CO3 : *Develop communication skills and capability to work in team*

Developing 8051 Assembly Language Programs using Trainer Kits

- Arithmetic and Logical operations (Addition, Subtraction, Multiplication and Division)
- Data manipulating Operations and Delay Routines
- String handling, (Block Move, Searching, Sorting, Swapping and Reversal)
- Solving a Polynomial, Palindrome and Generating Fibonacci Series

Interfacing Experiments

- Interfacing ADC
- Interfacing DAC

8051 Programming using KEIL IDE and Proteus Simulator

- Input/Output Port Programming.
- Timer/Counter Programming.
- Serial Port Programming.
- Handling Interrupts

Embedded 'C' programs using ARDUINO boards

- Data Acquisition using sensors
- Vehicle Tracking

TOTAL : 30

REFERENCES

1. *Microcontrollers Laboratory manual of ECE department, CIT.*
2. *Krishna Kant, "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051, 8096", Prentice Hall of India, Ist Edition, 2011.*
3. *Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, "The 8051 Microcontroller and Embedded Systems Using Assembly and C ", 2nd Edition, Pearson Education 2013.*

WEBSITE REFERENCE

https://www.coursera.org/learn/interface-with-arduino

19ECL47 - LINEAR INTEGRATED CIRCUITS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of the course, the students will be able to demonstrate an ability to,

CO1 : *Test and analyze the characteristics of operational amplifier and special purpose integrated circuits*

CO2 : *Design, simulate and test active filters, oscillators, multivibrators, comparators, Schmitt Trigger, data converters, PLL based frequency multiplier and voltage regulators*

CO3 : *Develop communication skills and capability to work in team*

LIST OF EXPERIMENTS

- Operational Amplifier Characteristics
- Operational Amplifier Applications
- Active Filters
- Oscillators & Multivibrators
- Comparator & Schmitt Trigger
- D/A & A/D Convertors
- Multivibrators using Timer IC
- PLL Characteristics and applications
- IC Voltage Regulators

TOTAL : 30

REFERENCES

1. *Linear Integrated Circuits Laboratory Manual of ECE Department, CIT.*
2. *Gayakwad Ramakant A, " Lab Manual to Accompany Op-Amps and Linear Integrated Circuits ", Prentice Hall, 4th Edition, 1999.*
3. *David A.Bell, "Laboratory Manual for Operational Amplifiers and Linear ICs", Oxford University Press, 2nd Edition, 2006.*

19EC51 - CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Ascertain the transfer function of Mechanical and Electrical systems using block diagram reduction and signal flow graph methods*

CO2 : *Determine time domain response, specifications, and steady state errors of first and second order systems and explain the importance of P, PI & PID controllers in control systems design.*

CO3 : *Sketch and estimate frequency domain specifications of all-pass & minimum phase systems using bode & polar plots.*

CO4 : *Test the stability of system by applying Root locus, Nyquist stability criterion and Routh Hurwitz criterion for a system transfer function.*

CO5 : *Draw state model of electrical systems, determine the solution of state equation using state space representation and test the controllability and observability of systems using Kalman's test.*

CONTROL SYSTEM MODELLING

Linear control systems- Open loop and closed loop systems- Examples of control system- Transfer function- Mechanical systems: Translational & Rotational systems- Electrical systems -Analogous system- Block diagram reduction method- Signal flow graph- Mason's gain formula **(9)**

TIME DOMAIN RESPONSE

Standard test signals - Type and order of systems -First order system -Step response analysis of second order feedback control systems - Time domain specifications - Steady state errors - Error constants- Introduction to P, PI and PID Controllers **(9)**

FREQUENCY DOMAIN RESPONSE

Introduction to frequency response - Frequency domain specifications- Bode plot- Polar plot- All pass and minimum phase systems- Introduction to Lead, Lag and Lead-Lag compensators **(9)**

STABILITY RESPONSE

Concepts of stability -S plane for stability - Necessary conditions for stability- Routh Hurwitz criterion- Root locus - Construction of root loci - Nyquist stability Criterion - Assessment of relative stability using Nyquist criterion **(9)**

SYSTEM STATE VARIABLE

Concepts of State, State variable and state model- State space representation using physical, phase and canonical variables (Electrical Systems) - State transition matrix - Solution of state equations - Concepts of Controllability & Observability (Kalman's test only) **(9)**

TOTAL : 45

TEXT BOOKS

1. *Nagrath,I.J. and M.Gopal, "Control Systems Engineering", New age International Publishers, 6th Edition, 2018.*

2. *Ktsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Private Limited, 5th Edition, 2015.*

REFERENCES

1. *Norman S.Nise, "Control Systems Engineering", John Wiley, 6th edition, 2018.*

2. *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison Wesley, 12th edition, 2013.*

3. *Farid Golnarghi and Benjamin C. Kuo, "Automatic control systems", Wiley student edition, 9th Edition, 2014.*

4. *A.Nagoor Kani, "Control Systems", RBA Publications, 2014.*

5. *W.Bolton, "Control Systems", Newnes, Elsevier Limited, 1st Edition, 2006.*

19EC52 - DIGITAL SIGNAL PROCESSING

	L	T	P	C
	3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Compute the Discrete Fourier Transform (DFT) of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms and to compute the linear convolution of discrete time sequences using DFT.*

CO2 : *Design IIR Butterworth and Chebyshev type I low pass and high pass digital filters for given specifications and realize IIR systems using direct, cascade and parallel form structures.*

CO3 : *Design Linear phase low pass and high pass FIR digital filters using windowing & frequency sampling methods and realize FIR systems using linear phase structures.*

CO4 : *Examine the effects of quantization error in digital filters.*

CO5 : *Explain the Applications of Digital Signal Processing.*

DISCRETE FOURIER TRANSFORM

Review of z Transform, Discrete Fourier Transform - Operations on Finite-Length Sequences - DFT Symmetry Relations - Discrete Fourier Transform Properties - Fourier Domain Filtering - Linear Convolution using the DFT - Radix-2 FFT Algorithms - Decimation-in-Time FFT algorithm, Decimation-in-Frequency FFT algorithm.   **(12)**

IIR DIGITAL FILTER DESIGN

Design of Discrete time IIR Butterworth and Chebyshev type I Low pass & High pass filters - Design of IIR Filter by Impulse Invariance and Bilinear Transformation - Structure of IIR Systems - Direct, Cascade and Parallel form structures.   **(10)**

FIR DIGITAL FILTER DESIGN

Symmetric and Antisymmetric FIR Filters - Design of Linear Phase low pass and high pass FIR Filters using Rectangular, Hamming & Hann Windows and Frequency Sampling Method - Design of FIR Differentiators - Structure of FIR Systems- linear phase structures.   **(9)**

FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS

Quantization Process and Errors - Quantization of Fixed point and Floating point numbers - A/D Conversion Noise Analysis - Dynamic range Scaling - Limit Cycles in IIR Digital Filter.   **(6)**

APPLICATIONS OF DIGITAL SIGNAL PROCESSING

Spectral Analysis of Sinusoidal Signals - Spectral Analysis of Nonstationary Signals - Noise Reduction and Two-Band Digital Crossover - Digital Music Synthesis - Signal Compression.   **(8)**

TOTAL : 45

TEXT BOOKS

1. *John G Proakis and Dimitris G Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, 4th Edition, 2007.*

2. *Sanjit. K. Mitra "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.*

REFERENCES

1. V. Oppenheim, R. W. Shafer and J.R.Buck, "Discrete-Time Signal Processing", Pearson Education, 4th Edition, 2011.

2. Ifeachor E.C. & Jervis B.W., "Digital Signal Processing: A Practical Approach", Pearson Education, 2nd Edition, 2002.

3. Lonnie C.Ludeman, "Fundamentals of Digital Signal Processing", Wiley, 2009.

4. Monson H Hayes, "Schaum's Outlines of - Digital Signal Processing", Tata McGraw Hill, 2nd Edition, 2012.

5. Li Tan, "Digital Signal Processing Fundamentals and Applications", Academic Press, 2008.

19EC53 - EMBEDDED SYSTEMS AND IoT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the hardware/software components of an embedded system for an application and infer the architecture & programming model of ARM processor.*

CO2 : *Infer the instruction set and exception types of ARM processor to develop Assembly language programs.*

CO3 : *Understand the serial and parallel communication devices and protocols and develop application software for embedded systems.*

CO4 : *Exemplify the key concepts in real time embedded application development using Real Time Operating System (RTOS).*

CO5 : *Interpret the characteristics, functional blocks and architecture of IoT to develop an IoT based applications.*

EMBEDDED COMPUTING AND ARM PROCESSOR

Embedded system overview and applications, features and architecture considerations - Embedded Systems vs General computing system- Classification of Embedded Systems -Typical embedded system: Core of the embedded system, Memory, Sensors & Actuators and Communication Interface

ARM Embedded System - CISC and RISC Processors - ARM Cortex M4 Architecture - Programmer's model- Operating Modes- Program status registers **(9)**

ARM CORTEX-M4 PROGRAMMING

ARM Instruction Set - ARM Instruction Types: Data Transfer, Data Processing, Control Flow, Data conversion, Bit field Processing and program flow control Instructions - Memory bit band operations - Interrupts - Exceptions types - NVIC Registers for interrupt control. **(9)**

DEVICES AND BUSES FOR DEVICES NETWORK

I/O Devices: Types and Examples of I/O devices, Synchronous, ISO-synchronous and Asynchronous Communications - Internal Serial-Communication Devices: SPI, SCI, SI, UART, Parallel Port Devices - Serial Communication Buses: I2C, USB, CAN- Advanced I/O Serial high speed buses: ISA, PCI, PCI-X and advanced buses. **(9)**

REAL TIME OPERATING SYSTEM

Foreground / Background systems - Critical section of code - Resource - Shared Resource - Tasks, Process and Threads, States - Types of Real-time tasks -Task Periodicity - Multiprocessing and Multitasking - RTOS Task scheduling models: Co-operative Round Robin Scheduling, Cyclic Scheduling with Time Slicing, RM and EDF -Priority Inheritance Protocol - Inter Process Communication : Semaphores , Message Queues , Mailboxes and Dead lock situations . **(9)**

IoT AND ITS APPLICATIONS

IoT Definition - Characteristics - IoT Functional Blocks -IoT Architecture -Physical design of IoT - Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Joseph Yiu, "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 processors", Elsevier - Newness publication, 3rd Edition, 2014.*

2. *Raj Kamal, "Embedded Systems Architecture, Programming and Design", Tata McGraw Hill, 2nd Edition, 2009.*

REFERENCES

1. *Andrew N.Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Morgan Kaufmann Publishers, 1st Edition, 2004.*

2. *Shibu K.V, "Introduction to Embedded Systems", Tata Mc Graw Hill, 1st Edition, 2009.*

3. *Jean J.Labrosse, "Embedded Systems Building Blocks", CMP Books, 2nd Edition, 2010.*

4. *Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.*

5. *Ying Bai, "Practical Microcontroller Engineering with ARM- Technology" IEEE Press & Wiley publishers, 2016.*

19EC54 - ANTENNAS AND WAVE PROPAGATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand the antenna fundamentals and parameters.*

CO2 : *Analyze the radiation characteristics of antenna array.*

CO3 : *Understand the radiation characteristics of special antennas.*

CO4 : *Illustrate antenna parameter measurement methods and Understand the characteristics of radio wave propagation.*

CO5 : *Interpret the physical significance of transmission line and impart knowledge in impedance transformation and matching using Smith chart.*

FUNDAMENTALS OF ANTENNA

Types of antennas - Radiation mechanism - Antenna parameters - Friis Transmission formula - Duality of Antennas - Retarded potentials - Radiation fields of oscillating dipole - Monopole and Half wave Dipole: Power radiated and Radiation Resistance. **(8)**

ANTENNA ARRAYS

Need for antenna arrays - Array of two point sources - Broad side array, End fire array, Pattern multiplication, N-element linear array, Binomial arrays - Log periodic dipole array - Phased array - Folded dipole - Yagi Uda antenna - Introduction to smart antennas. **(9)**

SPECIAL ANTENNAS

Loop antenna: emf equation of loop antenna - Application in Radio direction finding - Huygens' principle, Babinet's principle - Slot antenna(Quantitative) - Horn antenna - Pyramidal Horn - Conical Horn - Reflector antennas and their feed systems - Micro strip antennas: Basic Characteristics - Feeding methods - Rectangular patch: Transmission line model - Circular patch. **(9)**

ANTENNA MEASUREMENTS & WAVE PROPAGATION

Antenna Test Ranges: Elevated Ranges - Ground reflection ranges - Anechoic chambers & absorbing materials - Compact Antenna Test Ranges (CATRS) - Measurement of Gain - Radiation Pattern - Beam Width.

Wave propagation: Modes of propagation - Structure of atmosphere - Ground wave propagation - Sky wave propagation -Virtual height - Maximum usable frequency - Critical angle - Skip distance - Space wave propagation - Duct propagation. **(9)**

TRANSMISSION LINE THEORY

General Transmission Line equations - Transmission Line analysis: Voltage, Current and Input Impedance in a line - Reflection coefficient - Lossless Transmission Line - Special Termination conditions - Sourced and Loaded Transmission Line - Standing Waves Ratio - Quarter Wave transformer - Smith Chart - Single Stub Matching using Smith Chart. **(10)**

TOTAL : 45

TEXT BOOKS

1. *C.A.Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons Inc., 4th Edition, 2016.*

2. *Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design - Theory and Applications", Prentice Hall, 2nd Edition, 2009.*

REFERENCES

1. K.D.Prasad, "Antennas & Wave Propagation", Satya Prakashan, New Delhi, 3rd Edition , 2003.

2. John D.Kraus, Ronald J.Marhefka, Ahmad S Khan, "Antennas and Wave Propagation" Tata Mc Graw Hill, 4th Edition, 2010.

3. John.D.Ryder, "Networks, Lines and Fields", Prentice Hall of India, New Delhi, 2nd Edition, 1997.

4. Warren L. Stutzman, Gary A. Thiele, "Antenna theory and design", John Wiley and Sons Ltd., 3rd Edition, 2013.

5. A.R.Harish, M.Sachidananda, "Antennas and Wave Propagation", Oxford University Press, 1st Edition, 2007.

19ECL55 - SIGNAL PROCESSING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Analyze the Spectrum of Discrete time signals and frequency response of Linear Time Invariant systems.*

CO2 : *Implement and test FIR/IIR Low pass & High pass filters and analyze the quantization effects.*

CO3 : *Design and test the applications of Digital Signal Processing.*

LIST OF EXPERIMENTS

The following experiments are implemented using open source software and Fixed / Floating point DSP Processors.

- Verification of Linear Convolution, Circular Convolution and Correlation
- Spectral Analysis using FFT
- Design and testing of IIR Low pass and High Pass filters and analyze the quantization effects
- Design and testing of FIR Low pass and High pass filters using Windowing technique and analyze the quantization effects
- Applications of Digital Signal Processing

CASE STUDY

Sub band coding of Speech signal, Identification of Voice/Unvoiced/Silence regions of Speech, Echo Cancellation using NLMS Adaptive Filter

TOTAL : 30

REFERENCES

1. *Discrete Time Signal Processing Lab Manual, Department of ECE, CIT.*

2. *Sen M. Kuo, Bob H. Lee, and Wenshun Tian, "Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications", Wiley, 3rd Edition, 2013.*

3. *Rulph Chassaing, Donald S. Reay, "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416DSK", Wiley, 2nd Edition, 2011.*

4. *Donald Reay, "Digital Signal Processing and Applications with the OMAP - L138 Experimenter" Wiley, 2012.*

5. *Steven K Smith, "Digital Signal Processing-A Practical Guide for Engineers and Scientists", Newnes, 2003.*

19ECL56 - EMBEDDED SYSTEMS AND IoT LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Develop an ARM Assembly Language Programs for arithmetic & array operations, timer/counter operation and interrupts and interfacing hardware with ADC, Temperature sensor, I2C based Serial EEPROM.*

CO2 : *Demonstrate applications of IoT using NODE MCU ESP 8266/ ARDUINO boards*

CO3 : *Develop communication skills and capability to work in team.*

Experiments using ARM CORTEX M4 LPC 4088 /STM32F446 Processor

* Searching and Sorting an Array
* Code Conversion Techniques
* LED brightness control using PWM signal
* Time Delay Generation using Timer / Counter
* Programming External Interrupts
* Programming Serial Port using UART communication between target board and PC
* Temperature sensor LM 35 ADC Interfacing
* Interfacing I2C based Serial EEPROM

Embedded 'C' programs using NODE MCU ESP 8266/ ARDUINO boards

* IoT based weather monitoring system to track temperature and humidity data over the internet using Arduino and ThingSpeak.
* Track a Vehicle on Google Maps using Arduino, ESP8266 & GPS
* Data acquisition and control using the MQTT based cloud server with the user interface as Mobile APP and web browser
* Develop a simple home security system using Wi-Fi module, HC-SR04 ultrasonic sensor and the IFTTT app

CASE STUDY

Design an analog data acquisition system using sensors such as LDR, thermistor & LM35 , ADC, timer, interrupts and serial port.

TOTAL : 30

REFERENCES

1. *Embedded Systems Laboratory manual of ECE department, CIT.*
2. *Steve Furber, "ARM System-on-Chip Architecture", Second Edition, Pearson Edition, 2012.*
3. *Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.*
4. *STM32F446 Processor manual Link: https://www.st.com/resource/en/datasheet/stm32f446mc.pdf*

19EC61 - VLSI DESIGN

L	T	P	C
4	0	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Examine the I-V and DC characteristics of MOS transistors and sketch the layout of CMOS Circuits*

CO2 : *Design and compare the static and dynamic CMOS combinational circuits using different logic styles*

CO3 : *Design the static and dynamic CMOS sequential circuits using different logic styles*

CO4 : *Develop and design VLSI sub systems and memories*

CO5 : *Explain FPGA architectures and VLSI Testing methods*

MOS TRANSISTORS AND FABRICATION

CMOS Logic - VLSI Design flow - Ideal I-V Characteristics of MOS Transistors - Non-Ideal I-V Effects - DC Transfer characteristics - n-well CMOS Processing Technology - Stick Diagram and layout design rules - Layout of CMOS Circuits - Delay Estimation. **(12)**

COMBINATIONAL CIRCUITS DESIGN

Circuit Families: Logical Effort and Transistor Sizing - Static CMOS - Ratioed Circuits - Cascode Voltage Switch Logic - Dynamic Circuits - Pass transistor Logic - Transmission gate logic - Differential Circuits. **(12)**

SEQUENTIAL CIRCUITS DESIGN

Sequencing static circuits - Conventional CMOS Latches and flip-flops - Pulsed latches - Resettable latches and flip-flops - enabled latches and flip flops - Incorporating Logic into latches - TSPC Latches and flip-flops - Sequencing dynamic circuits. **(12)**

VLSI SUBSYSTEMS AND MEMORY DESIGN

Single bit Addition - Ripple Carry Adder - Carry look-ahead adder - Carry skip adder - Subtractor - One/Zero detectors - Comparators - Unsigned array and 2's complement array multipliers - Booth encoding - 6T SRAM and DRAM cell design - Power Dissipation in Memories. **(12)**

FPGA ARCHITECTURE AND VLSI TESTING

CPLD Architectures - FPGA Architectures: Organization - Programming Technologies - PLB Architectures - Programmable Interconnects - Programmable I/O Blocks.

Manufacturing Test Principles: Fault Models, Observability and Controllability, Fault Coverage and ATPG - Design for Testability: BIST and IDDQ Testing. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Neil H.E.Weste, David Harris "CMOS VLSI Design - A Circuits and Systems Perspective", Pearson Education, 4th Edition, 2015.*

2. *Charles H.Roth and Lizy Kurian John,"Digital System design using VHDL", John Wiley& Sons, 2nd Edition, 2013.*

REFERENCES

1. *V.S.V. Prabhakar K. Lal Kishore, "VLSI Design", John Wiley and Sons, First Edition, 2019.*

2. *Debaprasad Das, "VLSI Design", Oxford University Press, II Edition, 2015.*

3. *Kamran Eshraghian, Douglas A Pucknell, and Sholeh Eshraghian, "Essentials of VLSI Circuits and Systems", Prentice Hall of India, First Edition, 2005.*

4. *Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Prentice Hall of India, 2nd Edition, 2016.*

5. *John P.Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, 2009.*

19EC62 - DIGITAL COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Calculate channel capacity based on entropy and mutual information using Shannon's Channel capacity theorem*

CO2 : *Comprehend various error control encoding and decoding techniques*

CO3 : *Discuss Inter Symbol Interference problem in baseband data transmission and derive Nyquist criteria for distortion less transmission*

CO4 : *Describe and analyze different Digital modulation techniques on the basis of their spectral occupancy*

CO5 : *Discuss the design of optimal receiver for minimizing probability of error and analyze its performance*

INFORMATION THEORY

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel - Channel models - BSC and BEC channels - Shannon's channel coding theorem **(9)**

MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING

Linear block codes - Syndrome decoding - Cyclic codes: Generator polynomial - Parity check polynomial -Calculation of syndrome - Convolutional codes - Viterbi decoding- Introduction to Turbo codes **(9)**

BASEBAND TRANSMISSION AND RECEPTION

Baseband Binary PAM systems -Baseband Pulse shaping: Intersymbol Interference , Nyquist Criteria for distortion less Baseband Binary Transmission- Pulse shaping by Digital Methods -Duobinary Baseband PAM System - Optimum filter Realization using Matched filter and Correlator - Eye Diagrams **(9)**

DIGITAL MODULATION AND TRANSMISSION

Geometric Representation of signals - Generation and signal space representation of Binary Frequency Shift Keying - Binary Phase Shift Keying - DPSK, DEPSK, QPSK, M-ary PSK - Quadrature Amplitude modulation **(9)**

OPTIMAL RECEPTION OF DIGITAL SIGNAL

Optimum receiver for Digital Modulation Scheme: BFSK, BPSK, DPSK, QPSK- Probability of Error: BFSK, BPSK, DPSK, QPSK, M-ary PSK - Comparison of Modulation Systems **(9)**

TOTAL : 45

TEXT BOOKS

1. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.*

2. *Herbert Taub, Donald L Schilling and Gautam Saha, "Principles of Communication Systems", Tata McGraw Hill, 3rd Edition, 2008.*

REFERENCES

1. *Simon Haykins, "Digital Communications", 1st Edition, Wiley India edition, 2010.*

2. *K.Sam Shanmugam, "Digital and Analog Communication systems", John Wiley and sons,2008.*

3. *John G. Proakis and Masoud Salehi, "Digital Communications", McGraw-Hill Education, 5th Edition, 2008.*

4. *Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", Wiley India, 2nd Edition, 2013.*

5. *Todd K.Moon, "Error Correction Coding: Mathematical Methods and algorithms", John Wiley & Sons, 2005.*

19EC63 - DATA COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Develop and Illustrate frame transmission for a given scenario. Estimate utilization percentage of data links in networks. Outline the concepts of computer networks, its layered architecture, and switching mechanisms.*

CO2 : *Evaluate throughput at MAC layer level. Analyze adaptability of given data for a given LAN standard. Categorize given address into one of standard addressing techniques and schemes.*

CO3 : *Design subnet masks, sub-blocks addressing scheme and identify routing mechanisms to fulfill networking requirements.*

CO4 : *Analyze given Transport layer header and extract its field data. Describe the essential principles of transport layer protocols. Identify the key factors to improve the performance and QoS parameters of data communication networks.*

CO5 : *Describe the features and operations of various application layer protocols like TELNET, SMTP, FTP, HTTP, SNMP and to discuss the security issues in networks.*

NETWORK ARCHITECTURE AND DATA LINK LAYER

Introduction: Building Blocks - Links, Nodes - Layering and Protocols - OSI Architecture - Internet Architecture - Circuit Switching vs Packet Switching - Datagram Networks - TCP/IP Reference Model - Logical Link Control Functions - Framing - Stop and Wait Protocol for Noisy And Noiseless Channels - Go-Back-N Protocol For Noisy Channel - Selective Repeat Protocol For Noisy Channel. **(9)**

MEDIUM ACCESS SUBLAYER

Medium Access Layer: Random Access - Controlled Access - Wired LAN - IEEE 802.3: Standard Ethernet, IEEE 802.4: Token Ring - IEEE 802.5: Token Bus - Connecting Devices: Repeaters, Hubs, Switches and Gateways - Virtual LANs. **(9)**

NETWORK LAYER

Addressing -Logical - Physical Address Mapping - IPv4 - IPv6 - Address Resolution Protocol (ARP) - Reverse Address Resolution Protocol (RARP) - Internet Control Message Protocol (ICMP) - Internet Group Management Protocol (IGMP) - Forwarding and Routing techniques - Distance Vector Routing - Link State Routing. **(9)**

TRANSPORT LAYER

Process-to-Process Delivery - User Datagram Protocol (UDP) - Transmission Control Protocol (TCP) : Segments, Connection Establishment, Data Transfer, Termination , Flow Control, Error Control, Congestion Control - Stream Control Transmission Protocol (SCTP) - QoS - Flow classes - Queuing : FIFO, Priority and Weighted Fair Queuing - Traffic shaping: Leaky bucket and Token Bucket. **(9)**

APPLICATION LAYER & SECURITY

Teletype Network (TELNET) - Simple Mail Transfer Protocol (SMTP) - File Transfer Protocol (FTP) - Hyper Text Transfer Protocol (HTTP) - Simple Network Management Protocol (SNMP): SNMP Management Components, Structure, Information Base - Security: Symmetric Key, Asymmetric Key - Network Security: Message Confidentiality, Message Integrity, Message Authentication. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Behrouz.A. Forouzan, "Data Communication and Networking", Tata McGraw Hill, 5th Edition, 2013.*
2. *Stallings.W, "Data and Computer Communication", Pearson Education, 10th Edition, 2013.*

REFERENCES

1. *Larry L. Peterson, Bruce S. Davie , "Computer Networks: A Systems Approach", Elsevier Science 5th Edition, 2011.*

2. *J.F.Kurkose & K.W.Rose, "Computer Networking-A top down approach", Pearson Education, 7th Edition, 2012.*

3. *Ed Tittle, "Schaum's outlines - Computer Networking", McGraw Hill Professional, 2002.*

4. *Srinivasan Keshav, "An Engineering Approach to Computer Networking", Addision Wesley Professional, 2010.*

5. *Andrew S.Tanenbaum, David Wetherall, "Computer Networks", Pearson Education, 5th Edition, 2013.*

19ECL64 - VLSI DESIGN LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Design and simulate CMOS logic combinational & sequential circuits using backend tool*

CO2 : *Examine the power and stuck at faults in combinational circuits*

CO3 : *Work in teams to achieve goals and communicate effectively*

LIST OF EXPERIMENTS

- Characteristics of nMOS and pMOS transistors
- Design and Simulation of nMOS inverter, CMOS inverter and obtaining its transfer characteristics and Noise Margin
- Logic design using pass transistors, transmission gates and static CMOS logic
- Design and Simulation of dynamic CMOS circuits
- Design and Simulation of simple combinational circuits (encoder, multiplexer, code converters)
- Design and Simulation of ALU subsystem-Adders, Multipliers
- Design and Simulation of sequential circuits (counters, shift registers)
- Layout design of Digital logic circuits
- Design and Simulation of Memory cell
- Power analysis of Pseudo nMOS inverter and CMOS inverter
- Testing of Stuck at faults of combinational digital Circuits

TOTAL : 30

REFERENCES

1. *VLSI Design Laboratory Manual of ECE Department, CIT.*
2. *Neil H.E.Weste, David Harris "CMOS VLSI Design - A Circuits and Systems Perspective", Pearson Education, 4th Edition, 2015.*
3. *Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits : A Design perspective", Prentice Hall of India, 2nd Edition, 2016.*

19ECL65 - ANALOG AND DIGITAL COMMUNICATION LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Construct and test analog modulation, pulse amplitude modulation, pulse code modulation, digital modulation and demodulation circuits*

CO2 : *Simulate and test Linear Block Coders, Cyclic Coders and Convolutional Coders*

CO3 : *Develop communication skills and capability to work in team*

LIST OF EXPERIMENTS

- Generation and demodulation of Analog Modulated signal
- Generation and demodulation of Frequency Modulated signal
- Verification of sampling theorem for low pass signals and testing of pulse analog modulation circuits
- Testing of Pulse Digital Modulation circuits
- Generation and detection of BFSK, BPSK, QPSK and QAM modulation scheme
- Implementation of Linear Block Coders, Cyclic Coders and Convolutional Coders
- Testing the performance of Digital Communication system under AWGN using Software Defined Radio

TOTAL : 30

REFERENCES

1. *Robert W. Heath J., "Digital Communication Physical Layer Exploration Lab Using the NI USRP", National Technology & Science Press, 2012.*

2. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*

3. *Analog and Digital Communication Laboratory Manual, Department of ECE, CIT.*

19EC71 - DIGITAL IMAGE PROCESSING

L	T	P	C
4	0	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

C01 : *Describe the digital image formation process & its representation and compute forward and inverse transform for an image.*

C02 : *Apply image enhancement techniques in spatial and frequency domain for improving the visual perception of an image.*

C03 : *Describe noise models and apply restoration filters & morphological operators to an image.*

C04 : *Interpret image quality and describe image compression techniques.*

C05 : *Make use of image segmentation techniques to extract regions of interest from an image and construct descriptors to describe region in a form suitable for computer processing.*

DIGITAL IMAGE FUNDAMENTALS & TRANSFORMS

Fundamentals of Image processing - Image sampling and Quantization - Basic relationship between pixels. Image Transforms: Discrete Fourier Transform, Discrete Cosine Transform, Walsh Transform, Hadamard Transform, Haar Transform and Karhunen Loeve Transform. **(12)**

IMAGE ENHANCEMENT

Gray Level transformations - Histogram Processing - Smoothing Spatial filters - Sharpening Spatial filters - Smoothing Frequency domain filters: Sharpening Frequency Domanin Filters - Homomorphic Filtering - Color image fundamentals: RGB, HSI Models. **(12)**

IMAGE RESTORATION

Model of image degradation - Noise Models - Mean filters - Order statistics filters - Adaptive filters: Local noise reduction filter and Median filter - Linear position invariant degradations - Inverse filtering -Wiener filtering - Constrained least square filtering - Morphological operators - Dilation, Erosion, Opening and Closing. **(12)**

IMAGE COMPRESSION

Coding redundancy - Spatial and temporal redundancy - Irrelevant information - Measuring image information - Fidelity criteria - Image compression models - Image formats - Huffman coding- Arithmetic coding - LZW coding - Run length coding - Bit plane coding - Predictive coding - Block transform coding - JPEG Compression - Wavelet Coding. **(12)**

IMAGE SEGMENTATION AND DESCRIPTION

Point detection - line detection - Edge detection - Edge linking and boundary detection: Local processing, Global processing: Hough Transform - Thresholding: Global thresholding, Adaptive thresholding and Optimal thresholding - Region based segmentation - Image Representation: Chain codes Skeletons - Boundary descriptors: Simple descriptors, Shape numbers - Regional Descriptors: Simple descriptors, Topological descriptors, Texture. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Rafael C.Gonzalez & Richard E.Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018.*
2. *Jayaraman S, Esakkirajan S &Veerakumar T, "Digital image Processing", Tata McGraw Hill, reprint 2010.*

REFERENCES

1. *Anil.K.Jain, "Fundamentals of Digital Image Processing", Pearson, 2015.*
2. *Sid Ahmed M.A., "Image Processing - Theory, Algorithm and Architecture", McGraw Hill, 2009.*
3. *William K.Pratt, "Digital Image Processing", John Wiley, 4th edition, 2007.*
4. *Milan Sonka, Vaclav Hlavac & Roger Boyle, "Image processing, Analysis and Machine Vision", Thomson Asia Prt. Ltd, 4th Edition, 2015.*
5. *Georgy Gimel Jarb, Patrice Delmas, "Image processing and Analysis : A primer", World Scientyic Publishing Europe Ltd, 2020.*

19EC72 - MICROWAVE ENGINEERING & OPTICAL COMMUNICATION

L	T	P	C
4	0	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Analyze and characterize given system or networks based on their scattering parameters.*

CO2 : *Analyze the generation of Microwave signals and understand its construction*

CO3 : *Explain the operating principle of microwave semiconductor devices and measuring losses, VSWR, scattering and spectral parameters.*

CO4 : *Explain the concepts of optical fibers communication systems and various signal degradation factors associated with optical fibers*

CO5 : *Explain the various optical fiber measurements based on the transmission, optical and mechanical characteristics*

MICROWAVE DEVICE CHARACTERIZATION

Frequency Spectrum - Scattering Matrix - Properties - Transmission (ABCD) Matrix - Two port, Three port and Four port Network Characterization - Lossless Divider - Resistive Divider - 90 Quadrature Hybrid Coupler - 180 Hybrid Junction **(11)**

MICROWAVE GENERATION

High frequency limitations of conventional tubes - Principle of velocity modulation -Two cavity Klystron and Reflex klystron- Traveling wave tube amplifier- Magnetron oscillators - Gunn diode **(12)**

SEMICONDUCTOR DEVICES & MICROWAVE MEASUREMENTS

IMPATT Diode- TRAPATT diode - PIN diode - Tunnel diodes - Spectrum analyzer - Network analyzer - Insertion Loss, Attenuation and VSWR measurements - Impedance measurement by Slotted line method - Dielectric constant measurement by waveguide method. **(12)**

OPTICAL FIBER COMMUNICATION

Elements of an Optical Fiber Transmission link - Optical transmission basics - Light propagation in optical fiber- Optical Fiber Modes and Configurations - Optical Sources: LEDs, Laser Diodes - Detectors: PIN diode, APD- Signal Degradation in Optical Fibers: Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion. **(13)**

OPTICAL FIBER MEASUREMENTS

Fiber attenuation measurements-Dispersion measurements-Fiber refractive index profile measurements- Fiber cut off wavelength Measurements - Fiber numerical aperture measurements - Fiber diameter measurements-Field measurements: Optical Time domain Reflectometry. **(12)**

TOTAL : 60

TEXT BOOKS

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

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

3. *Keiser G, "Optical Fiber Communications", McGraw Hill, New Delhi, 4th edition, 2011.*

REFERENCES

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

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

3. *John M. Senior, "Optical Fiber Communications Principles and Practice", PHI, New Delhi, 3rd edition, 2009*

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

5. *S. Rao, "Microwave Engineering", Prentice Hall of India, 2nd Edition, 2015.*

19EC73 - WIRELESS COMMUNICATION AND NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate path loss, small scale and large scale fading in mobile channels*

CO2 : *Describe the cellular concepts, Channel Assignment Strategies, Multiple access techniques and interpret the cellular capacity*

CO3 : *Explain about the concept of different Digital Signaling for fading channels*

CO4 : *Compare different equalization algorithms & diversity techniques and conclude their choice for wireless channels*

CO5 : *Explain wireless network architecture with their standards*

MOBILE RADIO PROPAGATION

Radio Wave Propagation - Free Space Propagation Model - Ground Reflection Model, Diffraction, Scattering - Practical link budget design - Small scale fading - Time dispersion parameters - Coherence bandwidth - Doppler spread & Coherence time, Fading due to Multipath time delay spread - Fading due to Doppler spread. **(9)**

CELLULAR ARCHITECTURE

Frequency Reuse - Channel Assignment Strategies - Handoff Strategies - Interference and System Capacity - Trunking and Grade of Service - Capacity in Cellular Systems - Multiple access techniques: FDMA, TDMA, CDMA, OFDMA **(9)**

DIGITAL SIGNALING FOR FADING CHANNELS

Structure of a wireless communication link, Principles of Offset-QPSK, π/4-DQPSK, QAM Principle, Error performance in fading channels, OFDM principle - Cyclic prefix, Windowing, PAPR. **(9)**

MULTIPATH MITIGATION TECHNIQUES

Equalization - Adaptive equalization: Linear and Non-Linear equalization, Zero forcing and LMS Algorithms - Diversity - Micro and Macro diversity - Diversity combining techniques - Error probability in fading channels with diversity reception - Rake receiver. **(9)**

WIRELESS NETWORKS

GSM - 3G - 4G (LTE) - LTE-A - 5G - NFC systems - WLAN technology - WLL - Hyper LAN - Ad hoc networks - Bluetooth - UWB. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Rappaport.T.S, "Wireless communications", Pearson Education, 2nd Edition, 2010*

2. *Andreas.F. Molisch, "Wireless Communications", John Wiley - India, 2nd Edition, 2012.*

REFERENCES

1. *David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 1st Edition, 2005.*

2. *A.Goldsmith, Wireless Communications, Cambridge University Press, 2005.*

3. *Aditya K Jagannatham, "Principles of Modern Wireless Communication Systems Theory and Practice", McGraw Hill Education (India) Private Limited, 1st Edition, 2017*

4. *William Stallings, "Wireless Communications and networks", Pearson Prentice Hall of India, 2nd Edition, 2009.*

5. *Clint Smith. P.E, and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.*

19ECL74 - WIRELESS COMMUNICATION AND NETWORKING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Implement fading channel models, diversity & equalization techniques and multi carrier modulation techniques

CO2 : Simulate and test the performance of wireless communication systems and networks

CO3 : Develop communication skills and capability to work in team and acheive goals.

LIST OF EXPERIMENTS

The following experiments are implemented using software and hardware

- Large Scale & Small-Scale Fading Channel Modelling
- Equalization Techniques
- Diversity Techniques
- Spread Spectrum systems
- Space Time Block Codes
- OFDM Transmitter & Receiver
- Wireless communication systems design using Software Defined Radio (SDR)
- Simulation of wireless networks and their performance analysis

TOTAL : 30

REFERENCES

1. *Robert W. Heath J., "Digital Communication Physical Layer Exploration Lab Using the NI USRP", National Technology & Science Press, 2012.*

2. *Rappaport,T.S., "Wireless communications", Pearson Education, 2nd Edition, 2010.*

3. *Wireless Communication and Networking Laboratory Manual, Department of ECE, CIT.*

19ECL75 - HIGH FREQUENCY LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Test and measure parameters, interpret and analyze measured data, record and present results of tests on passive microwave devices & fiber optic devices*

CO2 : *Design & Simulate antenna and micro-striplines.*

CO3 : *Develop Communication Skills and capability to work in team and achieve goals.*

LIST OF EXPERIMENTS

- Measurement and Characterization of Passive devices: Isolator, Circulator, Magic Tee and Directional coupler
- Mode characteristics of Reflex Klystron
- Measurement of VSWR, Frequency, Guide Wavelength and Unknown Impedance.
- Measurement of Dielectric constant of a dielectric material.
- Measurement of Radiation pattern of Horn antenna and Dielectric antenna.
- Design, simulation and analysis of Microstrip-lines and antenna using Antenna Simulation software
- Analysis of the characteristics of microwave passive devices using antenna simulation software.
- Analysis of Fiber Optic Analog link's characteristics.
- Test and characterize the optical telecommunication network using OTDR.
- Analysis of standing waves formation in transmission line using FDR method.
- Analysis of Electric, magnetic fields and radiation pattern of an antenna using C program / PYTHON/ SCILAB.
- Analysis of field pattern of various modes inside a rectangular waveguide and rectangular cavity resonator

TOTAL : 30

REFERENCES

1. *Microwave & Optical Communication Manual of ECE Department CIT.*
2. *David M. Pozar, "Microwave Engineering", Wiley India (P) Ltd, New Delhi, 4th edition, 2012.*
3. *Keiser G, "Optical Fiber Communications", McGraw Hill, New Delhi, 4th edition, 2011.*
4. *K Das, "Microwave Engineering", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017*

19ECE01 - MULTIMEDIA COMPRESSION AND COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate various multimedia components and its characteristics.*

CO2 : *Determine the average length of text and image by various compression techniques, and calculate the compression ratio.*

CO3 : *Interpret the various techniques for audio and video compression.*

CO4 : *Illustrate the network architecture and various communication protocols for VoIP. Identify the challenges and key factors to improve the performance and QoS parameters of VoIP.*

CO5 : *Analyze the various multimedia networking protocols to provide the best effort service for Real time interactive multimedia application.*

MULTIMEDIA COMPONENTS

Introduction - Multimedia skills - Multimedia components and their characteristics - Text, sound, images, graphics, animation, video, hardware.   **(9)**

TEXT AND IMAGE COMPRESSION

Compression principles-Source encoders and destination encoders-Lossless and lossy compression-Entropy encoding -Source encoding- Text compression -Static Huffman coding , Dynamic Huffman coding - Arithmetic coding - Lempel Ziv-Welsh Compression - Image compression - Graphics interchange formate - Tagged image file format - JPEG   **(9)**

AUDIO AND VIDEO COMPRESSION

Audio compression-DPCM-Adaptive DPCM -Adaptive Predictive Coding-Linear Predictive Coding-Code Excited LPC- Perceptual coding - Video compression principles-H.261, H.263, MPEG 1, 2, 4.   **(9)**

VoIP TECHNOLOGY

Basics of IP transport, VoIP challenges, H.323/ SIP -Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service - CODEC Methods-VOIP applicability.   **(9)**

MULTIMEDIA NETWORKING

Multimedia networking- Applications- Streamed stored and audio-making - Best Effort service-Protocols for real time interactive applications- Distributing multimedia- Beyond best effort service- Secluding and policing Mechanisms- Integrated services, Differentiated Services-RSVP.   **(9)**

TOTAL 45

TEXT BOOKS

1.   *Fred Halshall,"Multimedia communication-Applications, Networks, Protocols and Standards", Pearson Education, 2013.*

2.   *Tay Vaughan, "Multideai: Making It Work", 7/e, TMH, 2007.*

REFERENCES

1. *Kurose and W. Ross, "Computer networking, A Top down Approach", Pearson education, 3rd Edition, 2010.*

2. *Marcus Goncalves, "Voice over IP Networks", McGraw Hill, 2nd Edition,1999.*

3. *KR. Rao,Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems : Techniques, Standards and Networks", Pearson Education,2007.*

4. *R.Steimnetz, K. Nahrstedt, "Multimedia Computing, Communications and Applications", Pearson Education,1st Edition, 1995.*

5. *Ranjan Parekh, "Principles of Multimedia", 3rd Edition, 2010.*

19ECE02 - DIGITAL SWITCHING AND TRANSMISSION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand the fundamental building blocks of digital switching and their operating principles including signaling.*

CO2 : *Explain the features and operation of time space switching mechanisms.*

CO3 : *Analyze and determine traffic parameters related to call connect and grade of service.*

CO4 : *Describe the concepts and explain the operating principles of network synchronization and clock recovery.*

CO5 : *Describe the structure of PDH, SDH and Cross connect networks and their operation*

EVOLUTION AND BUILDING BLOCKS OF SWITCHING SYSTEMS

Message switching and Circuit switching - Functions of switching systems - Distribution systems -Digital Switching Systems- Switching system hierarchy - Evolution of switching systems - Stored program control switching system - Basic Call processing- Call signaling - SS7 signalling. **(7)**

DIGITAL SWITCHING TECHNOLOGIES

Space Division switching - Folded switches - Digital Time Division switching - Combinational Two dimensional switching : Space-Time and Time-Space switching - Three dimensional : Space-Time-Space and Time Space Time switching - Digital Cross Connect Systems - DCS hierarchy. **(8)**

TELECOMMUNICATION TRAFFIC

Unit of traffic - congestion - traffic parameters - Busy Hours Call Attempt - Traffic Intensity - Call processing capacity- Call Completion Ratio - Call Blocking Probability - Grade of Service - Holding time distributions - Arrival time Distributions - Loss Systems - Erlang B-Formula - Delay Systems - Service Times - ErlangC Formula **(9)**

NETWORK SYNCHRONISATION

Timing Recovery - Clock instability - Jitter - Slips - Asynchronous Multiplexing - Plesiochronous Network Synchronisation - Pulse stuffing -Mutual synchronization - Master Slave synchronization -Hierarchical synchronization **(8)**

TRANSMISSION SYSTEMS

Network Structure - services - regulations - standards - Digital Transmission -PDH and SDH - SDH Features - Network evolution - Cross connect - Add-Drop Mux - SDH Frame structure. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Flood J E, "Telecommunications Switching, Traffic and Networks" first Indian reprint, Pearson Education India, 2001.*

2. *ThiagarajanViswanathan, ManavBhatnagar"Telecommunication switching systems and networks" 2nd Edition, PHI Learning, 2015.*

REFERENCES

1. *John C Bellamy, "Digital Telephony" John Wiley and Sons, 3rd Edition, 2006.*

2. *Bosse J G van, Fabrizio U. Devetak "Signaling in Telecommunication Networks" John Wiley & Sons,2nd Edition, 2006.*

3. *David R. Smith, "Digital Transmission Systems" Springer - Science + Business Media, LLC, 3rd Edition, Volume II, 2004.*

4. *P. Gnanasivan, "Telecommunication Switching and Networks", New Age International (P) Limited, 2007.*

5. *Micheal G. Solomon, Davind Kim, "Fundamentals of Communications and Networking", Jones & Bartlett Learning (LLC) 2021.*

19ECE03 - INTRODUCTION TO MACHINE LEARNING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand and illustrate a wide variety of examples in supervised and unsupervised learning algorithms.*

CO2 : *Analyze uncertain probabilities and make rational decisions to minimize risk with associate rules from data and understand the parametric approach for classification and regression models.*

CO3 : *Design a function that learns from a labeled multivariate sample by fine tuning the complexity of the data.*

CO4 : *Explain various feature selection methods to extract subset of important features from original inputs.*

CO5 : *Apply clustering methods to learn the mixture of parameters from data to various class and understand learning algorithms that build decision tree for labeled training samples in classification and regression models.*

LEARNING MODELS

Machine Learning - Learning Associations - Classification - Unsupervised Learning- Reinforcement Learning - Supervised Learning: Learning a Class from Examples - Vapnik - Chervonenkis (VC) Dimension -Probably Approximately Correct (PAC) Learning - Noise - Learning Multiple Classes - Regression - Model Selection and Generalization - Dimensions of a Supervised Machine Learning Algorithm. **(9)**

DECISION THEORY AND PARAMETRIC METHODS

Classification - Losses and Risks - Discriminant Functions - Association Rules - Parametric Methods: Introduction - Maximum Likelihood Estimation - Evaluating an Estimator: Bias and Variance - The Bayes' Estimator - Parametric Classification - Regression- Tuning model complexity. **(9)**

MULTIVARIATE METHODS

Multivariate Data - Parameter Estimation - Estimation of Missing Values - Multivariate Normal Distribution - Multivariate Classification - Tuning Complexity - Discrete Features - Multivariate Regression. **(9)**

DIMENSIONALITY REDUCTION

Subset selection - Principal Component Analysis- Feature Embedding-Factor Analysis- Singular Value Decomposition and Matrix Factorization- Multidimensional Scaling- Linear Discriminant Analysis. **(9)**

CLUSTERING AND DECISION TREES

Mixture Densities-k-means Clustering- Expectation Maximization Algorithm- Supervised Learning after Clustering- Decision Trees: Univariate Trees- Pruning- Rule Extraction from Trees-Learning rules from data-Multivariate trees. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, 3rd Edition, 2014, ISBN 978-0-262-02818-9.*

2. *Tom M.Mitchell, "Machine Learning", McGraw-Hill Private Limited, Indian Edition, 2017.*

REFERENCES

1. *Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman Hall/CRC 2nd Edition, 2015, ISBN 978-1-4200-6718-7.*

2. *Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2nd Edition, 2019, ISBN 978-0- 262-01825-8.*

3. *Peter Flatch, "Machine learning : The Art and Science of Algorithm that make sense of data", 1st Edition, Cambridge University Press, 2012.*

4. *Jason Bell, "Machine Learning - Hands-On for Developers and Technical Professionals", 1st Edition, Wiley, 2014.*

5. *Kevin P. Murphy, "Machine learning : A Probabilistic perspective", MIT Press, 2012.*

19ECE04 - SIGNAL PROCESSING USING PYTHON

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the principles of Numerical Python Basics

CO2 : Apply Numpy to perform filtering and Convolution

CO3 : Perform spectral analysis in Python

CO4 : Design and develop FIR digital filters using window methods in Python

CO5 : Design and develop IIR Butterworth and Chebyshev digital filters in Python

INTRODUCTION TO PYTHON

Introduction - Numpy-Numpy arrays and Memory - Numpy matrices- Numpy broadcasting - Matplotlib - Alternatives to Matplotlib - Ipython - Ipython Notebook - Scipy-Computer Algebra - Interfacing with compiled libraries. **(9)**

FILTERING AND CONVOLUTION

Smoothing - Convolution - Convolution theorem -Gaussian filter - Efficient convolution - Efficient autocorrelation - Differentiation - Integration - Cumulative sum - Integrating noise. **(9)**

SPECTRAL ANALYSIS

Sampling theorem - Reconstruction - Fourier transform matrix - DFT - zero padding - Circular convolution -Spectral analysis using windows - Window metrics. **(9)**

FINITE IMPULSE RESPONSE FILTER DESIGN

FIR Filters as Moving averages - Continuous frequency filter transfer function - z- Transform - Causality - Symmetry and Anti-symmetry - Filter design using Rectangular, Hamming, Hanning and Blackman window methods. **(9)**

INFINITE IMPULSE RESPONSE FILTER DESIGN

Design of Butterworth and Chebyshev filters- Frequency transformation - Properties of IIR filters - IIR filter design - Bilinear transformation and Impulse invariant transformation. **(9)**

TOTAL:45

TEXT BOOKS

1. *Jose Unpingco, "Python for Signal Processing", Springer International Publishing Switzerland 2014.*

2. *Allen B. Downey, "Digital Signal Processing in Python", Green tea press, 2014.*

REFERENCES

1. *Ludeman L C, "Fundamentals of Digital Signal Processing", John Wiley, Singapore, 1992.*

2. *Oppenheim A.V., Schafer R.W. & Buck J.R., "Discrete - Time Signal Processing", Prentice Hall Signal Processing Series, 3rd Edition, 2010.*

3. *J.G. Proakis, D.G Manolakis, "Digital Signal Processing principles, algorithms and applications", Pearson Education, 4th Edition, 2013.*

4. *Sanjit. K. Mitra, "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.*

5. *Mark Lutz, "Programming Python: Powerful Object-Oriented Programming", O'Reilly media Inc, 2011.*

19ECE05 - ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate the characteristics of random processes*

CO2 : *Estimate the frequency spectrum of random signal by using various power spectrum estimation techniques*

CO3 : *Design a Wiener filter to produce minimum mean square estimate for linear prediction and develop adaptive filter algorithms for real time signal processing application*

CO4 : *Analyze the spectral characteristics of sample rate converted discrete time signals by using interpolation and decimation*

CO5 : *Design filter banks with different structures for computational complexity reduction*

DISCRETE RANDOM SIGNAL PROCESSING

Discrete Random Processes - Ensemble averages, Gaussian process, Stationary processes, Autocorrelation and Autocovariance matrices, Ergodicity, Parseval's Theorem - Wiener-Khintchine Theorem - Power Spectrum, Filtering random processes, Spectral Factorization. **(9)**

SPECTRUM ESTIMATION

Estimation of spectra from finite duration signals, Non-Parametric Methods -Periodogram, Modified Periodogram, Bartlett and Welch methods, Blackman-Tukey method - Parametric Methods - AR, MA, and ARMA model based spectral estimation - Frequency Estimation. **(9)**

LINEAR PREDICTION AND FILTERING

Linear prediction - Forward and backward predictions - Solutions of the Normal equations - Levinson - Durbin algorithms - Least Mean Squared error criterion -FIR Wiener filter- IIR Wiener filter - FIR adaptive filters-LMS Algorithm. **(9)**

MULTIRATE SYSTEM

Review of Sampling theorem - Sub-Nyquist sampling-Basic Multirate operations - up sampling and down sampling - time domain and frequency domain analysis - Identities of Multirate operations; Interpolator and decimator design - Rate conversion. **(9)**

FILTER BANKS

Multirate Filter Banks: Maximally decimated filter banks - Quadrature mirror filter (QMF) banks - Polyphase representation - Filter banks with tree structure - Filter banks with parallel structure - Polyphase structures: Fundamentals of Polyphase structures - Polyphase QMF Banks - Polyphase filter Banks. **(9)**

TOTAL: 45

TEXT BOOKS

1. Monson H.Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Singapore, 2009.
2. N.J.Fliege, "Multirate Digital Signal Processing", John Wiley, 2000.

REFERENCES

1. Simon Haykin, "Adaptive Filter Theory", 4th Edition, Pearson Education,2008
2. John G.Proakis et.al, "Algorithms for Statistical Signal Processing", Pearson Education, 2003.
3. T.Adali and Simon Haykin, "Adaptive Signal Processing - Next Generation Solutions", Wiley India Pvt. Ltd., 2010.
4. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, PTR, 1993.
5. Fredric J Harris, "Multirate signal Processing For Communication Systems", 1st Edition, Pearson Education ,2007

19ECE06 - SPEECH SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the concepts of speech production*

CO2 : *Analyze the time domain parameters for speech processing*

CO3 : *Analyze the frequency domain methods for speech processing*

CO4 : *Illustrate the Linear Predictive analysis with its parameters for speech processing*

CO5 : *Infer the concepts of speech processing for real time applications*

MECHANICS OF SPEECH

Speech production: Mechanism of speech production, Acoustic phonetics - Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM.   **(9)**

TIME DOMAIN METHODS FOR SPEECH PROCESSING

Time domain parameters of Speech signal - Methods for extracting the parameters Energy, Average Magnitude, Zero crossing Rate - Silence Discrimination using ZCR and energy - Short Time Auto Correlation Function - Pitch period estimation using Auto Correlation Function.   **(9)**

FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING

Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder - Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders.   **(9)**

LINEAR PREDICTIVE ANALYSIS OF SPEECH

Basic Principles of linear predictive analysis - Auto correlation method - Covariance method - Solution of LPC equations - Cholesky method - Durbin's Recursive algorithm - Application of LPC parameters - Pitch detection using LPC parameters - Formant analysis - VELP.   **(9)**

APPLICATION OF SPEECH & AUDIO SIGNAL PROCESSING

Algorithms: Dynamic time warping, K-means clustering and Vector quantization, Gaussian mixture modeling, hidden Markov modeling - Automatic Speech Recognition: Command and Control application: Voice Repertory Dialer, Automated Call type Recognition, Call Distribution by Voice Commands, Credit Card Sales Validation.   **(9)**

TOTAL : 45

TEXT BOOKS

1. *L. R. Rabiner and R. W. Schaffer, "Digital Processing of Speech signals", Prentice Hall, 2004.*

2. *Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc., 2006.*

REFERENCES

1. *Thomas F.Quatieri, "Discrete-time Speech Signal Processing-Principles and Practice", Pearson Education, 2004.*

2. *L.R. Rabiner and B. H. Juang , "Fundamentals of speech recognition", Pearson Education, 2003.*

3. *Owens, F.J. "Signal Processing of Speech", McGraw-Hill, 1993.*

4. *Claudi Becchetti and Lucio Prina Ricotti,"Speech Recognition", John Wiley and Sons, 1999.*

5. *John R Deller and John H L Hansen, John G Proakis,"Discrete Time Processing of Speech Signals",Wliey-IEEE Press,2000.*

19ECE07 - WEARABLE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Categorize and explain the type of sensors used in wearable systems.

CO2 : Analyze the wearability issues in signal processing.

CO3 : Specify the types of energy harvesting methods for wearable devices.

CO4 : Explain the techniques used in wireless health systems.

CO5 : List out and explain the applications of wearable systems.

SENSORS

Need for wearable systems- Sensors for wearable systems-Inertia movement sensors- Respiration activity sensor- Inductive plethysmography- Impedance plethysmography- pneumography- Wearable ground reaction force sensor- GSR- Radiant thermal sensor- Wearable motion sensors- CMOS - Based Biosensors- E-Textiles- Bio compatibility.   **(9)**

SIGNAL PROCESSING

Wearability issues -physical shape and placement of sensor- Technical challenges - sensor design- signal acquisition- Constraint on sampling frequency for reduced energy consumption- light weight signal processing- Rejection of irrelevant information- Data mining.   **(9)**

ENERGY HARVESTING FOR WEARABLE DEVICES

Solar cell- Vibration based- Thermal based- Human body as a heat source for power generation- Hybrid thermoelectric photovoltaic energy harvests- Thermopiles.   **(9)**

WIRELESS HEALTH SYSTEMS

Need for wireless monitoring- Definition of Body area network- BAN and Healthcare- Technical Challenges- System security and reliability- BAN Architecture - Introduction- Wireless communication techniques.   **(9)**

APPLICATIONS OF WEARABLE SYSTEMS

Medical Diagnostics- Medical Monitoring-Patients with chronic disease- Hospital patients- Elderly patients- Multi parameter monitoring- Neural recording- Gait analysis- Sports Medicine- Smart Fabrics   **(9)**

TOTAL : 45

TEXT BOOKS

1. *Annalisa Bonfiglio,DaniloDe Rossi , "Wearable Monitoring Systems", Springer,2011.*

2. *Sandeep K.S. Gupta,TridibMukherjee,Krishna Kumar Venkatasubramanian, "Body Area Networks Safety,Security, and Sustainability",Cambridge University Press,2013.*

REFERENCES

1. *Hang,Yuan-Ting, "Wearable Medical Sensors and Systems",Springer,2013.*

2. *Mehmet R. Yuce,JamilY.Khan, "Wireless Body Area Networks Technology, Implementation and Applications",Pan Stanford Publishing Pvt.Ltd, Singapore,2012.*

3. *Guang-Zhong Yang(Ed.), "Body Sensor Networks", Springer,2007.*

4. *Andreas Lymberis, Danilo de Rossi , "Wearable eHealth systems for Personalised Health Management - State of the art and future challenges" ,IOS press, The Netherlands,2004.*

5. *Joseph J. Carr, John M. Brown, "Introduction to Biomedical Equipments technology", John Wiley & Sons, 4th Edition, 2015.*

19ECE08 - ADAPTIVE SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate the characteristics, applications and properties of Adaptive Systems.*

CO2 : *Explain theory of adaptation with stationary signals.*

CO3 : *Examine the concepts of gradient and mean square error performance in adaptive systems.*

CO4 : *Exemplify LMS algorithms and constraints associated with it.*

CO5 : *Describe the various applications of adaptive signal processing.*

ADAPTIVE SYSTEMS

Definition and characteristics, General properties, Open and Closed Loop Adaptations, Applications. Adaptive Linear Combiner: Performance function, Gradient and Mean Square Error, Examples. **(9)**

THEORY OF ADAPTATION WITH STATIONARY SIGNALS

Properties of the Quadratic Performance Surface, Significance of Eigen values, Eigen vectors, correlation matrix. Searching the Performance Surface: A simple gradient search algorithm, Stability and Rate of convergence, the learning curve. **(9)**

GRADIENT ESTIMATION AND ITS EFFECTS ON ADAPTATION

Gradient component estimation by derivative measurement, performance penalty, Variances of the gradient estimate, effects on the weight - vector solution, Excess mean square error and time constants, misadjustments, total misadjustments and other practical considerations. **(9)**

ADAPTIVE ALGORITHM AND STRUCTURE

LMS Algorithm, Derivation, Convergence of the weight vector, learning curve, noise vector in weight vector solution, misadjustment, Performance analysis **(9)**

APPLICATIONS OF ADAPTIVE SIGNAL PROCESSING

Adaptive modeling of a multi-path communication channel, model in geophysical exploration, FIR digital filter synthesis. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bernard Widrow and Samuel D. Stearns, "Adaptive Signal Processing", Person Education India, 2016.*

2. *Simon Haykin, Adaptive Filter Theory, Pearson Education, 2014.*

REFERENCES

1. *J. Benesty, Y. Huang, Adaptive Signal processing: Applications to Real World Problems, Springer , 2013*

2. *T. Adali and S. Haykin, ADAPTIVE SIGNAL PROCESSING: Next Generation Solutions, John Wiley & Sons Inc. , 2010*

3. *Sayed Ali, H., Fundamentals of Adaptive Filtering, John Wiley & Sons. 2003*

4. *John R. Treichler, C. Richard Johnson, Michael G. Larimore, Theory and Design of Adaptive Filters, Prentice-Hall of India, 2002.*

5. *D. G. Manolakis, V.K. Ingle, S.M. Kogon, Adaptive Signal Processing, McGraw-Hill , 2000.*

19ECE09 - INFORMATION THEORY AND CODING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Evaluate the information content in a discrete memoryless source through parameters such as entropy and mutual information.*

CO2 : *Estimate a channel's capacity based on Shannon's channel capacity theorem*

CO3 : *Construct efficient source coding schemes based on the entropy of source and probability of input variables*

CO4 : *Develop channel error control codes using BCH and RS algorithms*

CO5 : *Design of various coding techniques for AWGN and fading channels*

CONCEPT OF INFORMATION THEORY

Review of probability Theory - Random variables - Operations on single and multiple random variables-random process concept-Memoryless Finite Schemes- Self information measure - Entropy function - Conditional Entropies - Characteristics of Entropy function - Derivation of the noise characteristics of a channel - Mutual information - Redundancy - Efficiency and channel capacity - capacities of channels with symmetric noise structure.   **(9)**

CONTINUOUS CHANNELS

Definitions of different entropies - Mutual information - Maximization of the entropy of a continuous random variable - Entropy maximization problems - Channel capacity under the influence of additive white Gaussian Noise- Hartley Shannon's Law - Trade-off between Bandwidth and SNR - Comparison of different modulation methods- Information Capacity Theorem - Rate Distortion Theory.   **(9)**

ELEMENTS OF ENCODING

Separable binary codes - Shannon - Fano encoding - Necessary and sufficient conditions for noiseless coding - Shannon's binary coding - fundamental theorem of discrete noiseless coding - Huffman's code - Gilbert Moore coding - Fundamental theorem of discrete coding in presence of noise - Instantaneous Codes - Kraft Inequality and McMillan's Theorem - Average Length and Compact Codes - Geometric Representation - Arithmetic Coding   **(9)**

ERROR CONTROL CODES

Hamming's single error correcting code - BCH codes - Reed-Solomon codes - Decoding BCH and RS codes - finding the Error Locator Polynomial - Non-binary BCH and RS Decoding - Erasure decoding for Non binary BCH and RS codes -Turbo codes - Encoding Parallel Concatenated codes - Turbo MAP decoding algorithm - BCJR algorithm - Log likelihood ratio decoding   **(9)**

CODING OVER CHANNELS

AWGN channels-Coding gain-Encoding and decoding in AWGN channels-ML and MAP decoding for Repetition codes- Coding gain performances -Density Parity check (LDPC) codes, Gallager construction of LDPC codes-Tanner Graphs- Gallager decoding   **(9)**

TOTAL : 45

TEXT BOOKS

1. *Reza F M, "An Introduction to Information theory", McGraw Hill, 2000.*

2. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 1st edition, 2021.*

REFERENCES

1. *Richard B.Wells, "Applied Coding and Information Theory for Engineers", Pearson Education, 1st edition Indian reprint, 2009.*

2. *Ranjan Bose, "Information Theory Coding and Cryptography", Tata McGraw Hill,2nd Edition 2008.*

3. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*

4. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.*

5. *Simon Haykins, "Digital Communications Systems", 1st Edition, Wiley, 2013*

19ECE10 - COMMUNICATION SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Discuss the characteristics and properties of LTIV systems*

CO2 : *Analyze the spectral characteristics of discrete time signals by using filters and analyze the sample rate converted discrete time signals by interpolation and decimation*

CO3 : *Outline different bandpass modulation & demodulation techniques and compare their performance*

CO4 : *Apply channel coding procedure and calculate coding efficiency*

CO5 : *Analyze the performance of Spread Spectrum and OFDM system*

INTRODUCTION

Basics of LabVIEW - LabVIEW Coding Guidelines - Generating Signals - Generating Channel Models - Generating Symbols - Examples of Time-Varying Systems- Models for LTIV Systems - Time Domain Description for LTIV System - Frequency Domain Description of LTIV Systems - Properties of LTIV Systems - Random Process Models - Channel Modeling and Simulation. **(9)**

FFT AND DIGITAL FILTERS

Spectral Analysis using FFT, FIR Filters - Sampling - Quantization: Uniform Quantization, Non-uniform Quantization, Quantization Errors - FIR Filter Design by Windowing, Equi-ripple FIR Filters - Effects of Filter-Phase Response - Pulse-Shaping Filter - Upsampling - Down sampling - Resampling Filters: Half band Filters, Polyphase Filters. **(9)**

BANDPASS DIGITAL TRANSMISSION AND RECEPTION

Frequency Shift Keying (FSK) - Phase Modulation - Phase Shift Keying (PSK) - Differential Phase Shift Keying (DPSK) - Quadrature Amplitude Modulation (QAM) - M-ary keying- Comparison of Various Signaling - Signal Detection and Recovery: Matched filter detection, Threshold decisions - Performance Measurements- Bit-error rate, Error vector magnitude. **(9)**

CHANNEL CODING

Waveform Coding, Linear Block Coding, Cyclic Coding- Convolutional Coding and Viterbi Decoding - Trellis-Coded Modulation (TCM) - Turbo Coding -Low-Density Parity-Check (LDPC) Coding - Differential Space-Time Block Coding (DSTBC). **(9)**

WIRELESS COMMUNICATION SYSTEM

Performance analysis Spread Spectrum System, OFDM System - Simulation and Modeling. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Cory L.Clark, "Digital Signal Processing and Digital Communication using Labview", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.*

2. *Robert W. Heath J., "Digital Communication Physical Layer Exploration Lab Using the NI USRP", National Technology & Science Press, 2012*

REFERENCES

1. *Won Y. Yang, Yong S. Cho, Won G. Jeon, Jeong W. Lee, Jong H. Paik Jae K. Kim, Mi-Hyun Lee, Kyu I. Lee, Kyung W. Park, Kyung S. Woo, "MATLAB®/Simulink® for Digital Communication", A-Jin Publishing Co, 2009*

2. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*

3. William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport and Kurt L. Kosbar Principles of Communication Systems Simulation with Wireless Applications, Prentice Hall, 2004.

4. K. C. Raveendranathan, "Communication Systems Modelling and Simulation: Using MATLAB and Simulink", Universities Press (India) Private Limited, Hyderabad (AP), 2011.

5. Michel C. Jeruchim, Philip Balaban and K. Sam Shanmugan, "Simulation of Communication Systems", Plenum Press, New York, 1992.

19ECE11 - OVERVIEW OF INDUSTRY 4.0

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate design principle scenarios, principles and strategies of automation and the basic elements of automated system and explain transfer mechanisms and cyber physical systems*

CO2 : *Illustrate data acquisition systems objectives and Nyquist sampling theorem classification and types of filters and design of filters with their application*

CO3 : *Compare and distinguish the industrial advantages of Nano electrical and electronic devices and the significance of Nanotech in industrial application.*

CO4 : *Describe the machine to machine communication and their application over agriculture, health care and activity monitoring.*

CO5 : *Express Robot Classification. Robotic System Components, Different Orientation Descriptions and Robot control architecture.*

INTRODUCTION

Introduction to Industry 4.0 design principle scenarios, Automation in Production System, Principles and Strategies of Automation, BasicElements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines and cyber Physical systems. **(9)**

DATA ACQUISITION SYSTEMS

Data Acquisition Systems(DAS) - Objectives - General configurations - Transducers - Signal Conditioning - Instrumentation amplifiers - Noise Reduction Techniques in Signal Conditioning- Transmitters -Piezoelectric Couplers- Nyquist's Sampling Theorem classification and types of filters - Design of Filters- Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS **(9)**

NANOTECHNOLOGY

Industry Advantages of Nano electrical and electronic devices - Electronic circuit chips - Nano sensors and actuators, Optical switches - Diodes and Nano-wire transistors - Memory storage - Lighting and displays - Filters (IR blocking) - Quantum computers - 30 Energy devices - Medical diagnosis - Conductive additives - Lead-free solder - Nanocoating's -EMI shielding. **(9)**

INTRODUCTION TO IoT

Sensing, Actuation, Basics of Networking, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring. **(9)**

ROBOTIC SYSTEMS AND APPLICATION

Robot Definition, Robot Classification. Robotic System Components, Different Orientation Descriptions, Manipulator Kinematics and Mechanics of Robot Motion, Velocity Transformations, Static Forces Transformations, Manipulator Dynamics, Trajectory Planning, Inverse Dynamics Control, Robot Controller Architectures, Robot Sensing and Vision Systems, Introduction to Intelligent Robots, Robots In Manufacturing Automation. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Hermann, Pentek, Otto, 2016: Design Principles for Industry 4.0 Scenarios*
2. *"Industrial Automation and Control System Security Principles" by Ronald.L.Krutz 2016 edition*

REFERENCES

1. *The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj and Anupama C. Raman (CRC Press).*

2. *Introduction to Nanotechnology By Charles P. Poole, Jr., Frank J. Owens . A Wiley Interscience Publications 2003.*

3. *Robotics and Control by R K Mittal and IJ Nagarath TATA McGraw Hill Publications 2003.*

4. *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence By Jan Holler, VlasiosTsiatsis, Stamatis Karnouskos, Catherine Mulligan, Stefan Avesand, David Boyle · 2014*

5. *Handbook of Industry 4.0 and Smart Systems by Diego Galar Pascual, Pasquale Daponte, Uday Kumar, 2019.*

19ECE12 - CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the issues, scope and significance of various security mechanisms and services applicable to Communication networks.Explain and analyze, algorithms and techniques of Block and Stream ciphers.*

CO2 : *Describe the concepts and applications of Modern Symmetric Key Ciphers*

CO3 : *Describe the concepts and applications of Asymmetric Key Encipherment*

CO4 : *Explain about concepts and applications of Integrity Authentication and Key management*

CO5 : *Discuss the concepts of security at application, transport and network layer,*

NUMBER THEORETIC AND ALGEBRAIC ALGORITHMS

Significance of network and data security in todays communication scenario - Overall Classification - Integer Arithmetic Modular Arithmetic - matrices - Linear congruence Substitution ciphers - Transposition ciphers - Stream cipher- Block ciphers - Algebraic structures - GF(2n) fields. **(9)**

MODERN SYMMETRIC KEY CIPHERS

 Modern block ciphers - Modern stream ciphers - DES - AES - uses of modern block ciphers and stream cipher, Application Examples. **(9)**

ASYMMETRIC KEY ENCIPHERMENT

 Mathematics of cryptography - Primality Testing - Factorization - Chinese Remainder Theorem - Quadratic - Exponentiation & Logarithm - RSA, Rabin - Elliptic curve, Application Examples. **(9)**

INTEGRITY AUTHENTICATION AND KEY MANAGEMENT

Message integrity - random oracle model - message authentication - SHA-512 - WHIRL POOL Digital signature schemes Entity anthentication- password - challenge response - zero knowledge - Biometrics - Kerberos - symmetric key management - public key distribution - steganography, Application Examples. **(9)**

NETWORK SECURITY

Security at the Application Layer: E-mail - PGP - S/MIME - Security at the transport layer: SSL and TLS - Security at the network layer: IPsec, Two Security Protocol - Security Association - Internet Key Exchange - ISAKMP, Application Examples. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Behrouz A. Ferouzan, "Cryptography & Network Security", 5th Edition, Tata McGraw- Hill Education, 2011.*

2. *William Stallings,"Cryptography and Network security: Principles and practice", 7th Edition, Pearson Education,2016.*

REFERENCES

1. *Douglas R.Stlinson, "Cryptography Theory and Practice", CRC Press series on Discrete Mathematics and its application, 1995.*

2. *Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security Private Communication in a Public World", Pearson Education, 2nd Edition, 2003.*

3. *Atul Kahate ," Cryptography and Network security", 3rd Edition, McGraw-Hill Education, 2013.*

4. *Christos Douligeris, Dimitrios N. Serpanos, "Network Security: Current Status and Future Directions", John Wiley, 2007.*

5. *R.K.Nichols, "Wireless Security" Tata Mc Graw Hill Education, 2006.*

19ECE13 - PARALLEL AND DISTRIBUTED PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Describe the architecture of models of parallel computers

CO2 : Illustrate the key concepts of advanced processor and memory hierarchy technology

CO3 : Exemplify the types of pipelining methods for super scalar architecture

CO4 : Interpret the models, languages and compilers for parallel programming

CO5 : Infer the concepts of distributed systems.

PARALLEL ARCHITECTURE

Parallel Computer Models, Program and Network properties, Principles of scalable performance **(9)**

PROCESSORS AND MEMORY HIERARCHY, BUS

Advanced processor Technology, Super scalar and vector processor, Memory hierarchy technology, Virtual Memory Technology, Backplane Bus systems. **(9)**

PIPELINING AND SUPER SCALAR TECHNIQUES

Linear Pipeline, Nonlinear pipeline, Instruction pipeline, Arithmetic pipeline, Superscalar and super pipeline design, Parallel and scalable architectures- Multiprocessor and Multicomputers. **(9)**

SOFTWARE FOR PARALLEL PROGRAMMING

Parallel programming models, languages, compliers- Parallel Program Development and Environments. **(9)**

DISTRIBUTED SYSTEMS

Models, Hardware concepts, communication, synchronization mechanism, case study: MPI and PVM, Distributed file systems.
(9)

TOTAL : 45

TEXT BOOKS

1.   Hwang. K, "Advanced computer Architecture, Parallelism, Scalability, Programmability", Tata McGraw Hill, 1993.

2.   Tanenbaum A.S, "Distributed Operating Systems", Pearson Education, Asia, 2002.

REFERENCES

1.   Dezso Sima,Terence Fountain, Peter Kacsuk, "Advanced Computer Architectures", Pearson Education, 2007.

2.   Quinn, M.J., "Designing Efficient Algorithms for Parallel Computers", McGraw - Hill, 2003.

3.   Harry F. Jordan Gita Alaghband, " Fundamentals of parallel Processing", Pearson Education , 2003

4.   V.Rajaraman and C.Siva Ram Murthy, "Parallel Computers Architecture and Programming", PHI, 2000.

5.   Culler, D.E., "Parallel Computer Architecture, A Hardware - Software approach, Harcourt" , Asia Pvt.Ltd., 1999

19ECE14 - OPTICAL COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the working of an Optical component based on its scattering parameters*

CO2 : *Explain the architecture and traffic flow of different client layer Optical networks.*

CO3 : *Analyze traffic models applicable for wavelength routing networks and determine the cost trade-off for designing a ring network*

CO4 : *Illustrate the function of the Photonic packet switching network and explain different architecture of access networks*

CO5 : *Identify, illustrate and compare the management and control aspects of optical networks*

OPTICAL SYSTEM COMPONENTS

Optical transmission basics - Network evolution - Light propagation in optical fibers - Loss & bandwidth, System limitations, Non-Linear effects - Solitons - Optical Components: Couplers, Isolators, Circulators, Multiplexers & Filters - Optical Amplifiers - Switches - Wavelength Converters. **(9)**

OPTICAL NETWORK ARCHITECTURES

Introduction to Optical Networks - SONET/SDH -Optical Transport Network - Generic Framing Procedure-Ethernet -IP- Multiprotocol Label Switching - Resilient Packet Ring - Storage Area Networks **(9)**

WAVELENGTH ROUTING NETWORKS

WDM Network Elements-Optical Line Terminals, Optical Line Amplifiers, Optical Add/Drop Multiplexers, Optical Crossconnects-WDM Network Design - Cost Trade -offs-LTD and RWA problems -Dimensioning Wavelength -Routing Networks-Statistical Dimensioning Models- Maximum Load Dimensioning Models **(9)**

PACKET SWITCHING AND ACCESS NETWORKS

Photonic Packet Switching - OTDM - Multiplexing and Demultiplexing - Synchronization - Burst switching - Test beds -Access Networks - Network Architecture overview -Enhanced HFC -Fiber to the Curb **(9)**

NETWORK DESIGN AND MANAGEMENT SYSTEM

Transmission System Engineering - System model - Power penalty - Transmitter - Receiver - Optical amplifiers - Crosstalk - Dispersion - Wavelength stabilization - Overall design considerations - Control and management: Network management functions, Configuration management, Performance management, Fault management, Optical safety. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Rajiv Ramaswami, Kumar N. Sivarajan and Galen H Sasaki "Optical Networks: A Practical Perspective", Elsevier/Morgan Kaufmann, 3rd Edition, 2010.*

2. *C.Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", Prentice Hall of India, 2002.*

REFERENCES

1. Biswanath Mukherjee, "Optical WDM Networks", Springer Science, 2006.

2. Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multiwavelength Optical Networks - Architecture, Design and control", Cambridge University Press, 2nd Edition, 2009.

3. Govind P.Agrawal, "Fiber-Optic Communication Systems", John Wiley and Sons, 4th Edition, 2012.

4. P.E.Green, "Fiber Optic Networks", Prentice Hall, 1993.

5. Franz and Jain, "Optical communication systems", Narosa Publications, New Delhi, 1995.

19ECE15 - SOFT COMPUTING AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the basic concepts of artificial neural networks and fuzzy logic*

CO2 : *Analyze the various neural network algorithmsfor real time optimization problems*

CO3 : *Infer the concepts and methods of fuzzy systems*

CO4 : *Apply the Genetic algorithm for single objective and multiobjective optimization problems*

CO5 : *Interpret the techniques of hybrid computing algorithms and to develop an applications*

ARTIFICIAL NEURAL NETWORKS& FUZZY LOGIC

Artificial neural networks: Introduction, characteristics- learning methods - taxonomy - Evolution of neural networks- basic models - important technologies - applications.Fuzzy logic: Introduction - crisp sets- fuzzy sets - crisp relations and fuzy relations: cartesian product of relation - classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. **(9)**

NEURAL NETWORKS

McCulloch-Pitts neuron - linear separability - hebb network - supervised learning network: perceptron networks - adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network - unsupervised learning networks: Kohonenself organizing feature maps, LVQ - CP networks, ART network. **(9)**

FUZZY SYSTEMS

Membership functions: features, fuzzification, methods of membership value assignments-Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making. **(9)**

GENETIC ALGORITHM

Genetic algorithm and search space - general genetic algorithm - operators - Generational cycle - stopping condition - constraints - classification - genetic programming - multilevel optimization - real life problem-Multi-objective Optimization Problem Solving-Multi-Objective Evolutionary Algorithm (MOEA)- Non-Pareto approaches to solve MOOPs -Pareto-based approaches to solve MOOPs -Some applications with MOEAs. **(9)**

HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS

Neuro-fuzzy hybrid systems - genetic neuro hybrid systems - genetic fuzzy hybrid and fuzzy genetic hybrid systems - simplified fuzzy ARTMAP - Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers. **(9)**

TOTAL: 45

TEXT BOOKS

1. *S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.*

2. *J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education 2004.*

REFERENCES

1. S.Rajasekaran and G.A.VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.

2. George J. Klir, Ute St. Clair, Bo Yuan, "Fuzzy Set Theory: Foundations and Applications" , Prentice Hall, 1997.

3. David E. Goldberg, "Genetic Algorithm in Search Optimization and Machine Learning" Pearson Education India, 2013.

4. James A. Freeman, David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.

5. Simon Haykin, " Neural Networks and Learning Machines", 3rd Edition,PHI Learning, 2011.

19ECE16 - COGNITIVE RADIO COMMUNICATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the evolution of software defined radio and cognitive radio*

CO2 : *Illustrate the architecture of cognitive radio communication system*

CO3 : *Analyze and explain different spectrum sensing techniques and dynamic spectrum access*

CO4 : *Explain the MAC and Network layer design for Cognitive Radio*

CO5 : *Illustrate the applications of Cognitive Radio*

INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO

Evolution of Software Defined Radio and Cognitive radio - goals - benefits - definitions - architectures - enabling technologies - radio frequency spectrum and regulations. **(9)**

COGNITIVE RADIO ARCHITECTURE

Cognition cycle - orient - plan - decide and act phases - organization of CR - SDR as a platform for Cognitive Radio - Hardware and Software Architectures - Overview of IEEE 802.22 standard for broadband wireless access in TV bands. **(9)**

SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS

Introduction - Primary user detection techniques - energy detection - feature detection - matched filtering - cooperative detection and other approaches - Fundamental Tradeoffs in spectrum sensing - Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing - Fundamental Limits of Cognitive Radio. **(9)**

MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO

MAC for cognitive radios - Polling, ALOHA, slotted ALOHA, CSMA, CSMA / CA, Network layer design - routing in cognitive radios, flow control and error control techniques. **(9)**

APPLICATIONS OF COGNITIVE RADIO

Overview of security issues in cognitive radios, auction-based spectrum markets in cognitive radio networks, public safety and cognitive radio, cognitive radio for Internet of Things. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, "Cognitive Radio Communications and Networks - Principles and Practice", Academic Press, Elsevier, 2010*

2. *Huseyin Arslan, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Springer, 2014.*

REFERENCES

1. *Bruce A.Fette, "Cognitive Radio Technology", 2nd Edition, Elsevier Science, 2009.*

2. *Kwang Cheng Chen, Ramjee Prasad, "Cognitive Radio Networks", John Wiley and Sons, 1st Edition, 2009.*

3. *Ezio Biglieri, Andrea J. Goldsmith, Dr Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, "Principles of Cognitive Radio", Cambridge University Press, 2014.*

4. *Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series: Analog Circuits and Signal Processing, 2014.*

5. *Geetam Singh Tomar, Ashish Bagwari, Jyotshana Kanti, Introduction to Cognitive Radio Networks and Applications, CRC Press, Taylor & Francis Group,2016*

19ECE17 - NEXT GENERATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the concepts of SDN network and integration with LTE.*

CO2 : *Discuss the concepts of Traffic Transport and Network Management in SDMN*

CO3 : *Explain the principles of Resource and Mobility Management in SDMN*

CO4 : *Discuss the concepts of NGN architecture and service evolution*

CO5 : *Explain the features of NGN management and standardization*

SDMN-LTE INTEGRATION NETWORK

SDN Paradigm and Applications - SDN for Wireless Challenges - Leveraging SDN for 5G Networks Ubiquitous Connectivity - Mobile Cloud - Cooperative Cellular Network - Restructuring Mobile Networks to SDN - SDN/LTE Integration Benefits. **(9)**

NETWORK AND TRANSPORT LAYER MANAGEMENT IN SDMN

IPv6 - IPv6 PE - IPv6 VPN -Mobile IP-Mobile TCP- Mobile Network Function and Service Delivery Virtualization and Orchestration-NFV , SDN - Traffic Management in SDMNs - NFV & SDN in Packet Core. **(9)**

RESOURCE AND MOBILITY MANAGEMENT IN SDMN

QoE Framework Architecture - Quality Monitoring - QoE Enforcement - Software Defined Internet Mobility Management - Architecture of Mobile Virtual Network Operators - MVNO Developments in 3G, 4G, and LTE - Cognitive MVNO. **(9)**

NGN ARCHITECTURE

Evolution Towards NGN - Technology Requirements, NGN Functional Architecture - Transport Stratum, Service Stratum, Service/ Content Layer and Customer Terminal Equipment Function - NGN Entities, Network and Service Evolution - Fixed, Mobile, Cable and Internet Evolution Towards NGN. **(9)**

NGN MANAGEMENT AND STANDARDIZATION

NGN requirements on Management - Customer, Third Party, Configuration, Accounting, Performance, Device and Information Management. Service and control management - End-to-End QoS and security - ITU and GSI-NGN releases, ETSI-NGN concept and releases. **(9)**

TOTAL: 45

TEXT BOOKS

1. Madhusanga Liyanage, Andrei Gurtov and Mika Ylianttila, "Software Defined Mobile Networks beyond LTE Network Architecture", Wiley, June 2015.

2. Jingming Li Salina and Pascal Salina, "Next Generation Networks-perspectives and potentials", Wiley, January 2008.

REFERENCES

1. Savo G Glisic, "Advanced Wireless Networks- Technology and Business models", Wiley, 3rd Edition, 2016.

2. Thomas Plavyk, "Next generation Telecommunication Networks", Services and Management, Wiley & IEEE Press Publications, 2010.

3. Martin Sauter, "3G, 4G and Beyond bringing networks, devices and web together", Wiley, 2nd Edition, 2013.

4. Neill Wilkinson, "Next Generation Network Services", John Wiley Publications, 2002.

5. Monique J. Morrow, "Next Generation Networks", CISCO Press, 2007.

19ECE18 - WIRELESS ADHOC AND SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Outline the challenges & issues in the wireless Ad Hoc and sensor network and its subsystems and Interpret network architecture and its components*

CO2. : *Describe the essential principles of the MAC protocols for Wireless Ad Hoc Networks*

CO3 : *Explain the Routing & Transport protocols for Wireless Ad Hoc Networks*

CO4 : *Discuss the features of MAC & Routing protocols for WSN*

CO5 : *Explain the principles of localization tracking and infrastructure establishment in WSN*

FUNDAMENTALS OF AD HOC & SENSOR NETWORKS

Fundamentals of Wireless Communication Technology - The Electromagnetic Spectrum - Radio propagation Mechanisms - Cellular and Ad Hoc Networks (MANETs) - Issues in Ad hoc networks - Wireless sensor networks (WSNs): Challenges and Constraints - Single node architecture - Hardware components, Energy consumption of sensor nodes - Applications of Ad Hoc and Sensor Networks. **(9)**

MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols: A Media Access Protocol for Wireless LAN (MACAW), Busy Tone Multiple Access protocols - Contention based protocols with Reservation Mechanisms: Distributed Packet reservation Multiple Access Protocol (D-PRMA), Five Phase Reservation Protocol (FPRP) - Contention based protocols with Scheduling Mechanisms: Distributed Priority Scheduling and Medium Access in Ad Hoc Networks, Distributed Wireless Ordering protocol (DWOP). **(9)**

ROUTING PROTOCOLS AND TRANSPORT LAYER IN AD HOC WIRELESS NETWORKS

Issues in Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols - Table-Driven Routing Protocols - Destination Sequenced Distance Vector (DSDV) - Wireless Routing Protocol (WRP) - Cluster Switch Gateway Routing (CSGR) - Source-Initiated On-Demand Approaches - Ad hoc On-Demand Distance Vector Routing (AODV) - Dynamic Source Routing (DSR) -Temporally Ordered Routing Algorithm (TORA) --Location-Aided Routing (LAR) -Zone Routing Protocol (ZRP). **(9)**

MAC AND ROUTING FOR WIRELESS SENSOR NETWORKS

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Routing Protocols- Energy-Efficient Routing, Geographic Routing. **(9)**

LOCALIZATION TRACKING AND INFRASTRUCTURE ESTABLISHMENT

A Tracking Scenario - Problem formulation - Distributed representation and inference of states- Tracking multiple objects - Sensor models - Topology control - Clustering - Time synchronization - Localization and Localization Services **(9)**

TOTAL: 45

TEXT BOOKS

1. *C.Siva Ram Murthy and B.S.Manoj, "Ad Hoc Wireless Networks - Architectures and Protocols", Pearson Education, 2012.*

2. *Kazem Sohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley Interscience A John Wiley & sons, Inc., Publication, 2007.*

REFERENCES

1. *Carlos de Morais Cordeiro, Dharma Prakash Agarwal, "Ad hoc and Sensor Network: Theory and Applications", 2nd Edition, World Scientific Publishing Co, 2011.*

2. *Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.*

3. *Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks: An information processing Approach", Elsevier 2004.*

4. *C.K.Toh, "Ad Hoc Mobile Wireless Networks", Pearson Education, 2009.*

5. *Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks" John Wiley, 2010*

19ECE19 - WIRELESS NETWORKS AND STANDARDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : (i) Outline the concepts of TDMA , GSM, CDMA in the Second generation wireless cellular networks

(ii) Describe and compare the air interface techniques in the second generation systems.

(iii) Summarize the UMTS Services, air interface techniques, WCDMA and CDMA in the third generation systems

CO2 : Describe the working principles of various wireless standards and its operations

CO3 : Describe the Function of Mobile IP and Outline the various wireless application protocols

CO4 : Outline the various types wireless LANs and Summarize the Wireless LAN Standards

CO5 : Describe the features and operations of various Wireless Personal Area Networks and its standards

SECOND AND THIRD GENERATION: ARCHITECTURE AND PROCESS FLOW

Second Generation TDMA - GSM : Architecture, Air Interface, Channels, Voice-call setup, Hand over - EDGE architecture- Second Generation CDMA: Forward and Reverse channel, Call Handoff - Third Generation systems - UMTS network architecture **(9)**

WIRELESS SYSTEM OPERATIONS AND STANDARDS

Cordless systems : Time Division Duplex, DECT Operation, ADPCM- Wireless Local Loop : Propagation considerations for WLL- OFDM -WiMAX and IEEE 802.16 : Long-Term Evolution : System Architecture, Transmission Techniques ,Channels in the radio interface, Radio Resource Management. 5G -Objectives and usage scenarios, New Radio Air interface, RAN architecture. **(9)**

MOBILE IP AND WIRELESS APPLICATION PROTOCOLS

Mobile IP : Operation of Mobile IP, Discovery using Agent Solicitation , Move Detection ,Co-located addresses - Registration : Securing the Registration Procedure -Tunneling : IP-within-IP Encapsulation, Minimal Encapsulation - Wireless Application Protocol : Architectural Overview, Wireless Markup Language, WML Script, Wireless Application Environment, Wireless Session Protocol, Wireless Transaction Protocol, Wireless Transport Layer Security, Wireless Datagram Protocol **(9)**

WIRELESS LANS

Introduction - Spread Spectrum LANs : Configuration, Transmission issues - Narrowband Microwave LANs : Licensed Narrow Band RF, Unlicensed narrowband RF - IEEE 802.11: Architecture and services , Wi-Fi alliance, Medium Access Control ,Reliable Data Delivery, IEEE 802.11a/b Physical Layer - Introduction to 802.11n - Infrared LANs : Strengths and Weakness, Transmission techniques **(9)**

WPAN

Introduction - Radio Specification - Baseband and Specification - Link Manager Specification - Logical Link Control and Adaptation Protocol - IEEE 802.15: IEEE 802.15.3/a, IEEE 802.15.4 - UWB - Optical Wireless Wavelength division Multiplexing (OWWDM). **(9)**

TOTAL : 45

TEXT BOOKS

1. KavehPahlavan and Prashant Krishnamurthy, "Principles of Wireless networks - A unified Approach", Prentice Hall, 2013.

2. Clint Smith, P.E. and Daniel Collins, "3G Wireless Networks", Tata McGraw Hill, 2nd Edition, 2007.

REFERENCES

1.   William Stallings, "Wireless Communications and Networks", Prentice Hall, 2nd Edition 2009.

2.   Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kauffmann Publishers, 2007.

3.   Dharma PrakashAgarwal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", Thomson India, 3rd edition, 2011.

4.   Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005.

5.   Saad Z Asif, "5G Mobile Communication, Concepts and Challenges", CRC Press, 2019.

19ECE20 - 5G NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe about the fundamental concepts of 4G & 5G networks*

CO2 : *Explain about 5G Modulation Schemes*

CO3 : *Explain about Multiple Access techniques in 5G networks*

CO4 : *Analyze the behaviour of different optimization for power control*

CO5 : *Explain about Massive MIMO for 5G networks*

EVOLUTION OF 4G AND 5G NETWORKS

OFDM principle - Modulation, Cyclic Prefix, Challenges in 4G- Windowing, PAPR, Introduction to 5G, vision and challenges, 5G NR - New Radio - air interface of 5G, radio access, Ultra-Dense Network Architecture and Technologies for 5G- Concept and Challenges of UDN, GPP HeNB Architecture, Key Technologies of UDN- Flexible Networking, Multi-RATs Coordination.   **(9)**

5G MODULATION SCHEMES

Introduction to Equalization- types - Filter-bank based multi-carrier (FBMC), Universal filtered multi carrier (UFMC), Generalized frequency division multicarrier (GFDM) - Principles, Transceiver Block diagram, Frame structure, Resource structure, allocation, mapping, MIMO-GFDM.   **(9)**

MULTIPLE ACCESS TECHNIQUES IN 5G

NOMA - Principle- Superposition Coding, Successive Interference Cancellation, Power Domain NOMA, Sparse Code NOMA-types, Power Domain Sparse Code NOMA and IDMA Relaying: Cooperative NOMA- Benefits and Challenges, Half duplex relaying, Full duplex relaying, Amplify and forward relaying, Decode and forward relaying, Decode and forward relaying with PLNC, BER Analysis, Capacity Analysis.   **(9)**

POWER OPTIMIZATION ALGORITHMS

Introduction to Power Optimization- One Dimensional-Multi dimensional, Multi- Objective Optimization- Geometric - Cone Programming - Convex Optimization- Ant Colony- Genetic Algorithms-Fuzzy Logic- Heuristic Algorithms.   **(9)**

MASSIVE MIMO FOR 5G

Introduction, MIMO in LTE, Theoretical background, Single user MIMO, Multi-user MIMO, Capacity of massive MIMO: asic forms of massive MIMO implementation, Hybrid beamforming for interference clustering and user grouping, Channel models, Machine type communications, D2D communications and Coordinated Multipoint Transmissions.   **(9)**

TOTAL : 45

TEXT BOOKS

1. *Afif Osseiran, Jose.F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.*

2. *Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications", Springer, 2016*

REFERENCES

1. Saad Z Asif, "5G Mobile Communication,Concepts and Challenges", CRC Press

2. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, "Fundamentals of Massive MIMO", Cambridge University Press, 2018

3. Fei Hu, "Opportunities in 5G Networks: A Research and Development Perspective", CRC Press, Taylor & Francis Group, 2016.

4. Ashish Bagwari, Geetam Singh Tomar, JyotshanaBagwari, "Advanced Wireless Sensing Techniques for 5G Networks", CRC Press, Taylor & Francis Group, 2018.

5. Ajay R. Mishra , "Fundamentals of Network Planning and Optimisation 2G/3G/4G: Evolution to 5G", 2nd Edition, Wiley,2018.

19ECE21 - NETWORK ROUTING AND INFRASTRUCTURE MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand fundamental networking concepts*

CO2 : *Interpret concepts of switching, cable categories and connection tools.*

CO3 : *Understand IP addressing- IPV4 and IPV6 2 Understand Domain and work group users*

CO4 : *Analyze WAN technologies and connectivity options*

CO5 : *Understand configuration of domain names, security issues and infrastructure management*

NETWORK FUNDAMENTALS

OSI and TCP/IP models-Network Infrastructure based Components: Firewalls, Access points-Wireless controllers-Cloud resources on network architecture-Network topologies-Troubleshooting methodologies to resolve network problems. **(9)**

LAN SWITCHING TECHNOLOGIES

Switching concepts-MAC learning and aging-Frame switching-Frame flooding-MAC address table-Troubleshoot interface and cable issues-Configure, verify, and troubleshoot VLANs multiple switches. **(9)**

IPV4 AND IPV6 ROUTING TECHNOLOGIES

IPv4 addressing-Configure, verify, and troubleshoot IPv4 addressing and subnetting

IPv6 addressing-Configure, verify, and troubleshoot IPv6 addressing-routing concepts

components of a routing table-static routing and dynamic routing. **(9)**

WAN TECHNOLOGIES

WAN topology options-WAN access connectivity options-Metro Ethernet-Broadband PPPoE-Internet VPN-QoS concepts-Congestion management **(9)**

INFRASTRUCTURE SERVICES, SECURITY AND MANAGEMENT

DNS lookup operation-Configure and verify DHCP on a router-port security-traffic filtering-Local authentication-device-monitoring protocols-device management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Wendell Odom, "CCNA 200-301 Official Cert Guide Library" Cisco Press Publications, 1st Edition, 2019.*

2. *Todd Lammle, "CCNA Routing and Switching Complete Review Guide", 2nd Edition, Publisher(s): Sybex, 2017.*

REFERENCES

1. *Rich McMahon, "Introduction to Networking" Tata McGraw Hill Education, 2003.*

2. *Behrouz A. Forouzan,"Local Area Networks" McGraw Hill Edition, 2003*

3. *Michael J. Martin "Understanding the Network A Practical Guide to Internetworking", New RidersPublishing, 2000.*

4. *Todd Lammle, "CCNA : Cisco Certified Network Associate", Sybex Publisher, 5th Edition, 2005.*

5. *http://www.cisco.com/en/US/products/ps6642/products_white_paper0900aecd805ffde8.shtml.*

19ECE22 - RADAR AND NAVIGATIONAL AIDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Define radar parameters and effects of various factors on radar*

CO2 : *Compare MTI, Pulsed Doppler and CW radar systems and describe the principles of operation of delay line cancellers, filters and signal processing techniques and comprehend the effect of these on radar systems' performance.*

CO3 : *Explain the principles and operation of Sequential lobbing , Conical Scanning and Mono-pulse tracking radars*

CO4 : *Outline the principles and operation of radio navigation systems and landing systems*

CO5 : *Explain the principles and operation of various satellite based navigation systems and analyze various navigations satellites.*

RANGE EQUATION

Basic Radar - Radar Range equation - Radar parameters - Block diagram - Radar frequencies - Derivation of simple range equation - Effect of various factors : radar cross section, transmitted Power - Pulse repetition frequency - System losses - S/N ratio and propagation losses. **(9)**

MTI, PULSE DOPPLER and CW RADAR SYSTEMS

Doppler effect - Pulsed radar - CW radar - MTI and Pulsed Doppler radar - Block diagrams and principles of working - Delay line cancellers and filters - Staggered PRFs - Doppler filter banks -Digital MTI processing - Range gates and filters used in MTI - Comparison of radar systems. **(9)**

TRACKING RADARS

Basic principles of tracking in angle - sequential lobe switching - conical scanning - Monopulse tracking methods: Amplitude comparison and Phase comparison - Limitations to tracking accuracy - methods to reduce errors and inaccuracy -Low angle tracking - Tracking in range - Tracking in Doppler - Comparison of tracking radars. **(9)**

RADIO NAVIGATION AND LANDING AIDS

General principles - Radio compass Non Directional Beacon (NDB) - Automatic Direction Finding (ADF), VHF Omnidirectional Radio (VOR), Distance Measuring Equipment (DME) - Hyperbolic Navigation DECCA, OMEGA, LORAN - Mechanics of Landing: Instrument Landing System - Microwave Landing System. **(9)**

SATELLITE NAVIGATION SYSTEM

Basics of Satellite Navigation - Global Positioning System (GPS) - Basic principles - Position, velocity determination- Differential-GPS (DGPS)-Navigation Satellites of different countries such as GLONAS and COMPASS, IRNSS, NAVIC Receiver and applications. **(9)**

TOTAL : 45

TEXT BOOKS

1. *M.I.Skolnik ,"Introduction to Radar Systems", Tata McGraw Hill , 3rd Edition, 2017.*

2. *Myron Kyton and W.R.Fried "Avionics Navigation Systems" John Wiley & Sons, 2nd Edition, 1997.*

REFERENCES

1. *Nagaraja "Elements of Electronic Navigation", Tata McGraw Hill, 2nd Edition, 1996.*

2. *Nathansan, "Radar design principles-Signal processing and environment", Scitech Publishing, 2nd Edition, 1999.*

3. *Hofmann-Wellenhof, Hlichlinegger and J.Collins, "GPS Theory and Practice", 5th Revised Edition, Springer Verlag , 2012*

4. *B. Bhatta "Global Navigation Satellite Systems Insights into GPS, GLONASS, Galileo, Compass, and others", BS Publications, 1st Edition, 2011.*

5. *www.gsa.europa.eu*

19ECE23 - SATELLITE COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Outline the elements and types of satellite orbits, determine the orbital parameters*

CO2 : *Describe the subsystems of satellite communication systems and earth station systems*

CO3 : *Apply the link design for signal to noise ratio calculations*

CO4 : *Explain different multiplexing techniques for satellite systems*

CO5 : *Describe the use of satellite systems for various applications*

SATELLITE ORBITS AND TRAJECTORIES

Orbital Mechanics: Orbit Equations, Kepler's Laws, Orbital Period, Orbit types - Look angle determination - Orbital effects on communication system performance - Satellite Launch. **(8)**

SATELLITE AND EARTH STATION SUBSYSTEMS

Satellite Subsystems: Power, Transponders, Antennas - AOCS, TTC&M - Earth station systems : Transmit-Receive Earth stations - Effects of earth- Perturbation, sun transit outage , moon transit outage - Satellite power design, Reliability **(8)**

LINK DESIGN

Basic transmission theory - System noise temperature and G/T Ratio- Noise figure and noise temperature- Calculation of system noise temperature - G/T ratio for earth stations - Link budgets - Uplink and downlink budget calculations - Error control for digital satellite links - Prediction of rain attenuation and propagation impairment counter measures. **(10)**

MULTIPLE ACCESS FOR SATELLITE COMMUNICATION

Frequency division Multiple Access (FDMA), Single Channel per Carrier systems (SCPC), Multiple Channel per Carrier systems (MCPC), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Space Domain Multiple Access (SDMA) **(9)**

APPLICATIONS

Communication Satellites- Frequency Bands, Payloads, Satellite Telephony, Satellite Television- Direct -to-Home satellite television, VSAT, Remote Sensing Satellites: Classification of remote Sensing systems, orbits, Payloads, Weather Forecasting Satellites: Fundamentals, Images, Orbits, Payloads, Navigation Satellites: Development of Satellite Navigation Systems, GPS system and its working principles. **(10)**

TOTAL : 45

TEXT BOOKS

1. Dennis Roddy, "Satellite Communications", Mc Graw Hill, 4th Edition, 2006.

2. T.Pratt, C. Bostian and J.Allnutt, "Satellite Communications", John Wiley and Sons, 2nd Edition, 2014.

REFERENCES

1. *W.L.Pritchard, H G Suyderhoud and R A Nelson, "Satellite Communication System Engineering", 2nd Edition, Prentice Hall, 1993.*

2. *Anil K. Maini, Varsha Agrawal," Satellite technology: principles and applications, Wiley India Pvt. Ltd., 2nd edition, 2015.*

3. *Tri. T. Ha, "Digital Satellite Communications", McGraw Hill, 2nd Edition, 1990.*

4. *Manojit Mithra ,"Satellite Communication", Prentice Hall,2005.*

5. *M. Richharia, "Satellite systems for Personal Applications", John Wiley, 2010.*

19ECE24 - DATA STRUCTURES AND ALGORITHMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe algorithm, its notations and its complexity*

CO2 : *Analyze the algorithms with the knowledge of basic data structures such as arrays, stacks and queues with implementations*

CO3 : *Use the concept of linked lists with different possible operations and applications and apply the concept of trees in data structures*

CO4 : *Apply the suitable graph algorithm for given applications*

CO5 : *Analyze sorting and searching algorithms for given applications*

INTRODUCTION TO DATA STRUCTURES

Data Vs Information - Representation of numbers: Integer, Real, Representation of Characters - Definition of an algorithm - Basic steps in development of an algorithm - Algorithm notations - Sparks - Algorithm complexity - Space and Time complexity - Order notations **(9)**

ARRAYS, STACKS AND QUEUES

Data structures - Abstract Data Types - Basic data structures: Representation of arrays, Array operations- Fundamentals of Stacks, Queues, Priority queues- Dequeues - Application of stacks: Recursion - Evaluation of expressions - Application of Queue-Job Scheduling-ALGORITHMS: Introduction-Analysis of algorithms -Best, worst and average case time complexities-notations. **(9)**

LINKED LISTS AND TREES

Lists: Operations - Singly linked lists, doubly linked lists, Circularly linked lists-Applications: Linked Stacks-Linked queues-Linked Priority queues- Application of Linked lists: Polynomial manipulation

Trees:Terminologies - Binary trees: Sequential and linked representation -operations -Traversals, Binary search tree--Expression trees -Infix, Postfix and Prefix expressions - Heaps-Max heap-Min heap. **(9)**

GRAPHS

Graphs: Definition - representations (Adjacency matrix, packed adjacency list and linked adjacency list) - Graph search methods (Breadth first and depth first traversals)-Connected components- spanning trees-Shortest path: Warshall algorithm, Dijkstra's Algorithm -Transitive closure - Activity networks -Topological sort. **(9)**

SORTING AND SEARCHING TECHNIQUES

Sorting algorithms: Selection sort- Bubble sort- Insertion sort - Shell sort - Quick sort - Heap sort - Merge sort-Searching: Linear search, Binary search, - Hashing Techniques **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ellis Horowitz, Sartaj Sahni, "Fundamentals of Data Structures in C", Galgotia Publications, 2008.*

2. *Jean-Paul Tremblay and Paul G. Sorenson, "An Introduction to Data Structures with Applications" McGraw Hill, 2nd Edition, 2008*

REFERENCES

1. A. Chitra, P. T. Rajan, "Data Structures", Tata McGraw Hill Education, 2008.

2. Thomes H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein "Introduction to Algorithms", The MIT Press, 2009.

3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 1997

4. Seymour Lipschutz, "Data Structures", Schaum's Outline, McGraw Hill, 2011.

5. Balagurusamy, "Data Structures using C", McGraw Hill, 2013.

19ECE25 - OPERATING SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Outline the basic functionalities of operating systems, operating system components, various types of operating system and system software, and features of Macro-processors, linkers and loaders.*

CO2 : *Demonstrate process control and apply scheduling algorithms.*

CO3 : *Apply principles of mutual exclusion and synchronization techniques to demonstrate process execution.*

CO4 : *Examine various memory management schemes and find suitable technique to design a system.*

CO5 : *Describe disk scheduling algorithms, Secondary storage management techniques, file organization and access methods.*

OPERATING SYSTEM OVERVIEW

Objectives and functions of OS - Evolution of OS - Distributed System - Real-Time systems - Operating system components - Interrupts - System call - Virtual Machines - Symmetric Multiprocessing - Microkernel. Macro processor.   **(9)**

PROCESS DESCRIPTION AND CONTROL

Process - Process states - Process description - Process control -Processes and Threads - Uniprocessor Scheduling: Types of Processor Scheduling - Scheduling Algorithms - Overview of Multiprocessor Scheduling and Real time scheduling.   **(9)**

MUTUAL EXCLUSION AND SYNCHRONIZATION

Principles of concurrency - Mutual exclusion: Software and hardware approaches - Semaphores - Monitors - Message Passing - Readers/ Writers problem. Deadlock and Starvation: Principles of deadlock - Deadlock Prevention - Deadlock Detection - Deadlock Avoidance.   **(9)**

MEMORY MANAGEMENT

Memory management requirements - Memory partitioning - Loading and Linking - Paging - Segmentation. Virtual Memory: Hardware and control structures - Operating Systems software: Fetch Policy, Placement policy, Replacement policy, Resident set management, Cleaning policy, Load control.   **(9)**

I/O MANAGEMENT AND FILE MANAGEMENT

I/O devices - Organization of I/O function - OS design issues - I/O buffering - Disk scheduling. File management: Overview - File organization and access - File directories - File sharing - Record blocking-Secondary storage management. Casestudy: Linux   **(9)**

TOTAL : 45

TEXT BOOKS

1. *William Stallings, "Operating Systems Internals and Design Principles", Pearson Education, 9th Edition, 2019.*

2. *Silberchatz, Galvin, Gagne, "Operating System Concepts", John Wiley, 9th Edition, 2018.*

REFERENCES

1. *Harvey M. Deitel, Paul J. Deitel, David R. Choffnes, "Operating Systems", Pearson Education, 3rd Edition, 2007.*

2. *Gary Nutt, "Operating System", Addison Wesley, USA, 2009.*

3. *Andrew S Tanenbaum and Herbert Bos, "Modern Operating Systems", Prentice Hall of India, New Delhi, 2015.*

4. *Dionysios C. Tsichritzis and Philip A. Bernstein, "Operating Systems Academic Press, London, 2014.*

5. *Achyut S Godbole, Atul Kahate, "Operating Systems", Mc Graw Hill, New Delhi, 2011.*

19ECE26 - REAL TIME APPLICATIONS USING PYTHON

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Infer the programming concepts of Python to develop simple computational programs.*

CO2 : *Implement Python programs with conditionals & loops and functions.*

CO3 : *Use Python lists, tuples & dictionaries for representing compound data and perform input/output with files.*

CO4 : *Implement Python programs using OOPs concepts.*

CO5 : *Develop real time applications of Raspberry Pi3 using LEDs , Sensors, LCD Display & Servo motor control and web server.*

INTRODUCTION TO PYTHON

Basic Syntax Variable and Data Types Operator: int, float, boolean, string, and list -Variables, expressions, statements, tuple assignment, precedence of operators, comments -Modules and functions, function definition and use, flow of execution, parameters and arguments - Illustrative programs: Exchange the values of two variables - Circulate the values of n variables - Distance between two points.　　　　　　　　　　　**(9)**

CONTROL FLOW & FUNCTIONS

Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else) - Iteration: state, while, for, break, continue, pass - Fruitful functions: return values, parameters, local and global scope, function composition, recursion - Strings: string slices, immutability, string functions and methods, string module - Lists as array s- Lists, Tuples, Dictionaries- Illustrative programs: Square root - GCD - Exponentiation - Sum an array of numbers - Linear search - Binary search　　**(9)**

LISTS, TUPLES, DICTIONARIES & FILE HANDLING

Lists - List Operations - Mutation - Aliasing - Cloning - Tuple assignment - Tuple as return value - Dictionaries: Operations and methods - Advanced list processing - List comprehension - Variables - Illustrative programs: Selection sort - Insertion sort - Mergesort, Histogram.

Files and exception Handling : text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: Word count - Copy file.　　　　　　**(9)**

CLASSES AND INHERITANCE

Object Oriented Programming - Class Instances - Class and object- Attributes -Inheritance -Overloading - Overriding - Data hiding- An Extended Example: Building a Class - Visualizing the Hierarchy - Adding another Class - Using Inherited Methods - Grade book - Generators.　　　　　　　　　　　　　　　**(9)**

PROGRAMMING THE RASPBERRY PI 3 USING PYTHON

Programming General Purpose Input / Output (GPIO) port pins -Interfacing seven segment LED and LCD Display , servomotor - Real time Monitoring & Data logging System using I2C protocol - Email notifier using Gmail SMTP server -Data Acquisition and control for Industrial/ Home Automation using MQTT Protocol.　　　　　　　　**(9)**

TOTAL : 45

TEXT BOOKS

1.　*Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Shroff/O'Reilly Publishers, 2016.*

2.　*Sai Yamanoor& Srihari Yamanoor, "Python Programming with Raspberry Pi" Packt Publishing, 1st Edition, 2017.*

REFERENCES

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

2. John V Guttag, "Introduction to Computation and Programming Using Python", 1st Edition, MIT Press, 2013.

3. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" 1st Edition, Network Theory Ltd., 2011.

4. Robert Sedgewick, Kevin Wayne and Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.

5. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python" McGraw-Hill, 1st Edition, 2013

19ECE27 - DESIGN FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand the concepts of electric vehicle components, efficiency and vehicle dynamics.*

CO2 : *Illustrate about electric and hybrid vehicle architecture and power train components.*

CO3 : *Describe the concepts of battery fundamentals and fuel cell, super capacitor energy storage.*

CO4 : *Design the different types of power electronics converters and electrical machines.*

CO5 : *Describe the concepts of hybrid vehicle control strategy.*

INTRODUCTION TO ALTERNATIVE VEHICLE AND VEHICLE MECHANICS

Electric Vehicles-Hybrid Electric Vehicles- Electric and Hybrid Vehicle Components-Vehicle Mass and Performance-Well to wheel analysis- EV/ICE Comparison: Efficiency comparison,Pollution comparison-capital and operating cost comparison - Electric Vehicle Market-Road way fundamentals-Vehicle kinetics-Dynamics of vehicle motion-Propulsion power-Velocity and acceleration-Tire road force mechanics **(9)**

ALTERNATIVE VEHICLE ARCHITECTURE

Electric Vehicles-Hybrid series and parallel architecture-Plug in Hybrid Electric Vehicle- Power train component sizing: EV Power train component sizing, HEV Power train component sizing, HEV Power train component sizing example-Mass analysis and packaging- Vehicle simulation. **(9)**

ENERGY STORAGE

Batteries in Electric Vehicle- Battery basics-Battery parameters- Electro chemical fundamentals-Battery Modeling: Circuit Model, Empirical Model-Traction Batteries-Battery pack management- Fuel Cell based energy storage, Super Capacitor and Flywheel based energy storage. **(9)**

POWER ELECTRONICS CONVERTERS AND ELECTRIC MACHINES

Power Electronic Switches- DC / DC converter: Non isolated and isolated converters-Cell balancing converters- Fundamentals of Electric Machines-Simple DC Machine-Three phase AC Machines-Types of AC Machines: Induction Machine, Permanent Magnet Synchronous Machine (PMSM)- Switched Reluctance Machine. **(9)**

HYBRID VEHICLE CONTROL STRATEGY

Vehicle supervisory Controller-Mode selection strategy: Mechanical Power split hybrid model- Series and parallel Hybrid modes-Series, parallel, Series and parallel control Strategies-Energy storage system Control-Regeneration control. **(9)**

TOTAL : 45

TEXT BOOKS

1. *IqbalHussain, "Electric & Hybrid Vehicles - Design Fundamentals", Second Edition, CRC Press,2011*
2. *Ali Emadi, MehrdadEhsani, "Vehicular Electric Power Systems" Marcel Dekker, Inc., New York, 2014.*

REFERENCES

1. *SandeepDhameja, "Electric Vehicle Battery Systems" Newnes, an imprint of Elsevier, 2013.*
2. *J.M.Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), London, UK, 2004*
3. *James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.*
4. *Indian vehicle emission standards: https://www.dieselnet.com/standards/in/2wheel.php*
5. *Mehrdad Ehsani, "Modren Electric, Hybrid Electric and Fuel cell vehicles", 1st Edition, CRC Press, 2017.*

19ECE28 - AUTOMOTIVE ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Design modules for hybrid vehicle using automotive system components.*

CO2 : *Modify the automobile Electronic Engine Control to improve fuel economy, safety and comfort in Automobiles as per the government test procedures.*

CO3 : *Design control system in automotives by appropriate choice of Sensors and actuators.*

CO4 : *Determine the vehicle parameters to control engine functioning and interpret vehicle's self-diagnostic codes.*

CO5 : *Examine internal communication network that interconnects the components inside a vehicle to reduce the fatal accidents and delays*

AUTOMOTIVE VEHICLE SYSTEMS

Basics of the gasoline (SI) engine - Method of operation, Fuel supply - Fuel delivery with manifold injection, Fuel delivery with gasoline direct injection - Inductive ignition system - Design, Function and method of operation - Spark plugs - Function, usage, electrode - Transmission System: Manual, Automatic Transmission - Differential - Braking system - Steering system - Rack and pinion, power steering - Electronic systems: Starting system, Charging system - Hybrid Electric Vehicle Power train Control.   **(9)**

ELECTRONICS IN AUTOMOTIVE SYSTEMS

Need for Electronic Engine Control - Exhaust Emissions - Fuel Economy - Federal Government Test Procedures - Concept of an Electronic Engine Control System - Exhaust Catalytic Converters - Electronic Fuel Control System - Open-Loop Control, closed-Loop Control - Analysis of Intake Manifold Pressure - Idle Speed Control - Electronic Ignition System - Electronic Suspension System - Electronic Steering Control - Antilock Braking System - Safety & Comfort systems: Night Vision, Airbags and Seatbelt pre-tensioner.   **(9)**

AUTOMOTIVE SENSORS & ACTUATORS

Automotive engine control sensors: Air Flow Rate Sensor, Engine Crankshaft and Camshaft Position Sensor - Throttle Angle Sensor - Intake & Exhaust Temperature - Rail Pressure - Cylinder Pressure & boost pressure Sensors - Sensors for Feedback Control: lambda sensor, Knock Sensors - Automotive Engine Control Actuators: Throttle actuator - Exhaust Gas Recirculation (EGR) - Oil pump - VVT valve.   **(9)**

AUTOMOTIVE INSTRUMENTATION AND DIAGNOSTICS

Modern Automotive Instrumentation - Display Devices - LED, LCD, Transmissive LCD, VFD, Flat Panel Display. Measurements: Fuel Quantity, Coolant Temperature, Oil Pressure, Vehicle Speed - Trip Information Computer - Telematics - Diagnostics: Onboard Diagnostics Model - Diagnostic Fault Codes - Onboard Diagnosis (OBD II).   **(9)**

VEHICLE COMMUNICATION PROTOCOLS

Vehicle Communication Protocols: CAN, LIN, FLEXRAY, MOST   **(9)**

TOTAL : 45

TEXT BOOKS

1. William B. Ribbens, "Understanding Automotive Electronics", Elsevier Publications, 7th Edition, 2012.

2. Robert Bosch Gmbh, "Automotive Handbook", 10th Edition, 2018.

REFERENCES

1. William B. Ribbens, "Understanding Automotive Electronics", Elsevier Publications, 6th Edition, 2003.

2. Konard Reif, "Gasoline Engine Management : Systems and Components", Springer Fachmedien Wiesbaden, 2015

3. Denton. T, "Automobile Electrical and Electronics Systems", 3rd Edition, SAE (Society for Automobile Engineers) International, 2004.

4. Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009

5. Barry Hollembeak, "Today's Technician: Automotive Electricity and Electronics (Classroom manual)", Delmar Cengage Learning, 4th Edition, 2006.

19ECE29 - ADVANCED PROCESSOR ARCHITECTURES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Exemplify the architecture, trends and applications of parallel processing and memory systems.*

CO2 : *Elaborate the principles and classification of pipelining concepts.*

CO3 : *Develop clear idea about the networking concepts and algorithms for array processors.*

CO4 : *Illustrate the architectural principles & programming of multiprocessor and concepts on system deadlocks.*

CO5 : *Describe architecture, features and applications of MSP430 Microcontroller and TMS320C6713 DSP processor.*

PARALLEL PROCESSING, MEMORY AND INPUT-OUTPUT SUBSYSTEMS

Trends towards Parallel Processing - ParallelComputer Structures - Architectural Classification Schemes - Parallel Processing Applications. Hierarchical Memory Structure -Virtual Memory System - Cache Memories - Input-Output Subsystems.   **(9)**

PRINCIPLES OF PIPELINING AND VECTOR PROCESSING

Principles of Linear Pipelining- Classification of PipelineProcessors-General Pipelines and Reservation Tables- Interleaved Memory Organizations- Principles of Designing PipelinedProcessors- Characteristics of Vector Processing-Pipelined Vector Processing Methods - Architecture of Cray-I Vector Processor.   **(9)**

STRUCTURES AND ALGORITHMS FOR ARRAY PROCESSORS

SIMD Array Processors: SIMD Computer Organization, Makingthe data routing mechanism. SIMD Interconnection Networks: Static Vs Dynamic Networks, Mesh-Connected IlliacNetwork, CubeInterconnection Networks, Barrel Shifter and Data Manipulator-ParallelAlgorithms for Array Processors: SIMD Matrix Multiplication,Parallel Storing on Array Processors and SIMD Fast Fourier Transform.   **(9)**

MULTIPROCESSOR ARCHITECTURE, PROGRAMMING, CONTROL AND ALGORITHMS

Loosely Coupled Multiprocessors-Tightly Coupled Multiprocessors-Processor Characteristics for Multiprocessing. Interconnection Networks: Time shared or CommonBuses- Crossbar Switch and Multiport Memories-Inter-process Communication Mechanisms: Process Synchronization Mechanisms,Synchronization with Semaphores, Conditional Critical Sections and Monitors. System Deadlocks and Protection:System Deadlocks and Protection, Deadlock Prevention and Avoidance- Deadlock Detection and Recovery and ProtectionSchemes.   **(9)**

MSP430 MICROCONTROLLER AND TMS320C6713 DSP PROCESSOR

Introduction- - MSP 430 Architecture -Features - DigitalI/O : Input Registers , Output Registers , Direction Registers , Pull Up and Pull down Enable Registers Function Select Registers ,Configuring Unused Port Pins Digital I/O Registers -TMS320C6000 family overview- Typical Applications - TMS320C67x DSPfeatures and Options - Architecture - CPU-CPU Data Paths - Functional Units - On-chip Peripherals: DMA, EDMA, HPI,McBSP and Timers.   **(9)**

TOTAL : 45

TEXT BOOKS

1.   *Venkataramani B, Bhaskar M, "Digital Signal Processors: Architecture, Programming & Applications", Tata McGraw HillPublishing Company Ltd., New Delhi, 2011.*

2.   *MSP 430X2xx Family User's Guide", Texas Instruments*

REFERENCES

1. *Hesham El-Rewini, Mostafa Abd-El-Barr, "Advanced Computer Architecture and Parallel Processing" Wiley, 2005.*

2. *SPRU197d.pdf (TMS320C6000 Technical Brief), Texas Instruments*

3. *SPRU733A.pdf (TMS320C67x/67x+ DSP CPU and Instruction Set Reference Guide, Texas Instruments.*

4. *Kai Hwang "Advanced Computer Architecture : Parallelism, Scalability, Programmability" Mc Graw Hill, 1st Edition, 2001.*

5. *Michel Dubois, Murali Annavaram, "Parallel Computer Organization and Design", Cambridge University Press, 2012.*

19ECE30 - IoT BASED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret architecture for IoT and system management based of IoT.*

CO2 : *Examine the communication technologies and protocols of IoT.*

CO3 : *Familiarize with the physical devices and logical design of IoT.*

CO4 : *Design simple IoT systems comprising sensors, edge devices, wireless network connections, data analytics capabilities and cloud storage.*

CO5 : *Describe IoT based applications for Home, Industry Automation, agriculture and productivity applications*

IoT ARCHITECTURE

Definition of Internet of Things- Realization of IoT Ecosystem using Wireless Technologies: Architecture for IoT using Mobile devices- Mobile Technologies for supporting IoT ecosystem- Layered architecture for IoT- Protocol architecture of IoT-Infrastructure Protocols- IoT and M2M- Software defined networking - Network function virtualization-IoT System Management with NETCONF-YANG, SNMP, NETOPEER   **(9)**

COMMUNICATION TECHOLOGIES AND PROTOCOLS OF IoT

IoT point to point communication technologies- IoT Communication Pattern- IoT protocol Architecture- Selection of Wireless technologies: 6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi, Widi- IoT protocols and softwares: MQTT - UDP -MQTT brokers - Publish & subscribe modes - HTTP - COAP -XMPP and gateway protocols.   **(9)**

PHYSICAL DEVICES & LOGICAL DESIGN

Basic building blocks of a IoT Device- Python packages of interest for IoT, Python web application framework. Programming Inputs and outputs, Serial, SPI and I2C - Sensors and sensor Node and interfacing using any Embedded target boards: Raspberry Pi- OPEN SOURCE HARDWARE: Raspberry PI physical devices, Raspberry Pi Interfaces, Pi Programming APIs/Packages, Web services.

CASESTUDIES : Real time applications of IoT- Connecting IoT to cloud.   **(9)**

INTRODUCTION TO CLOUD COMPUTATION AND BIG DATA ANALYTICS

Cloud Computing: Grid/SOA and Cloud Computing-Cloud Middleware- Mobile cloud computing- Big data analytics tools and technology

Cloud Support : Cloud Storage models and communication APIs Webserver - Web server for IoT - Cloud for IoT - Designing a RESTful web API - Amazon Web services for IoT - Data Analytics for IoT : Apache Hadoop - Using map reduce for batch data analytic.   **(9)**

IoT APPLICATION AND ITS VARIANTS

Envisioning Futuristic Smart Airports using IoT Integration- Envisioning Smart Health care systems in a connected world- Smart use cases of IoT: Strategic Governance framework for the implementation of Smart cities, Smart Industrial use cases of IoT, Smart lighting for energy conservation, Smart transportation systems, Connected cars.   **(9)**

TOTAL : 45

TEXT BOOKS

1.   Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk - Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016

2.   LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.

REFERENCES

1.   Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally, "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014.

2.   Pethuru Raj, Anupama C. Raman, "The Internet of Things Enabling Technologies, Platforms, and Use Cases", CRC Press(Taylor & Francis Group), 2017.

3.   Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.

4.   Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly Media Press, Ist Edition, 2012 .

5.   Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2012.

19ECE31 - REAL TIME OPERATING SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Determine the concepts of Real time operatingsystems.*

CO2 : *Illustrate the concepts of scheduling and implement the algorithm to develop Real time operating systems*

CO3 : *Explain and summarize the concepts of multiprocessor system.*

CO4 : *Determine the concepts of distributedin Real time systems*

CO5 : *Exemplify the performance and benchmarking of RTOS*

INTRODUCTION TO REAL TIME OPERATING SYSTEMS

Introduction-Producing quality software-modeling the software-the importance of time and timing-handling multiple jobs-handling complex multiple jobs-using interrupts as the execution engine-simple quasi -concurrency-basic features of real time operating systems **(9)**

SCHEDULING CONCEPTS AND IMPLEMENTATIONS

Introduction-simple cyclic, timed cyclic and cooperative scheduling- task priorities-priority pre-emptive scheduling-using queues-implementing queues-the processor descriptor-tick-priority and system responsiveness-By passing the scheduler-code sharing and reentrancy **(9)**

MULTI PROCESSOR SYSTEMS

Processor structures-multi core processors-multi computer structures-software issues-structuring software as a set of functions-structuring software as a set of data processing operations-software control and execution issues-scheduling and execution of AMP, SMP, BMP system **(9)**

DISTRIBUTED SYSTEMS

Software structuring in distributed systems-communication and timing aspects of distributed systems-mapping software onto hardware in distributed systems **(9)**

PERFORMANCE AND BENCHMARKING OF RTOS

Introduction-measuring computer performance-computation performance benchmarking-OS performance-Time overhead in processor system-OS performance and representative bench mark-basic requirements-test categories-test stressing methods **(9)**

TOTAL:45

TEXT BOOKS

1. *Dr.Jim Cooling, "Real time operating systems",Lindentree Associates, 2018.*

2. *J. Labrosse Jean "Mc/os-III The Real-time kernel for the in Fineon XMC 4500" Micrium Publishers, 2012.*

REFERENCES

1. *K.C.Wang, "Embedded and Real time operating systems",Springer International Publishing, 2017.*

2. *Qing li, "Real time concepts for embedded systems" 3rd Edition,Taylor and francis limited, 2017.*

3. *Chowdary Venkateswara Penumuchu "Simple Real-time Operating System: A Kernel Inside View for a Beginner" Trafford Publishing, 2007*

4. *Rajib mall, "Real-time Systems: Theory and Practice "Pearson Education India, 2009*

5. *Qing Li, Caroline Yao, "Real-time Concepts for Embedded Systems", CRC Press, 2017.*

19ECE32- ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Describe the concepts of robotics, safety measures and homogeneous transformation.*

CO2 : *Formulate the concepts of mechanical drives and sensors in robotics.*

CO3 : *Exemplify the concepts of artificial intelligence and problem solving by searching.*

CO4 : *Develop robotics programming, classifications and its applications.*

CO5 : *Illustrate the methodologies in robot task planning and problem solving techniques.*

ROBOT KINEMATICS

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics. Robot kinematics - forward and reverse kinematics of three and four degrees of freedom robot arm-Homogeneous transformation - Kinematics equations using homogeneous transformation. **(10)**

ROBOTIC DRIVERS, CONTROLS AND SENSING SYSTEMS

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism- Need for sensing systems - Sensory device - Types of sensors - Robot vision systems - Low level vision and high-level vision. **(9)**

ARTIFICIAL INTELLIGENCE AND ROBOTICS

Artificial intelligence and automated manufacturing - AI and robotics -Solving problems by searching- Problem solving agents: Search problems and solutions, Formulating problems- Search algorithms- Uninformed search strategies: Breadth-first search, Dijkstra's algorithm, Depth-first search, iterative deepening search, Bidirectional search- Informed search strategies: Greedy best-first search, A* search, Search contours, satisficing search, Memory-bounded search, Bidirectional heuristic search **(9)**

ROBOTIC LANGUAGE AND PROGRAMMING

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language.Application of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance. **(8)**

ANALYSIS AND TASK PLANNING

Robot intelligence and task planning - Use of predicate logic - Means and Ends analysis - Problem solving - Robot learning - Robot task planning - Basic problems in task planning- Expert systems and Knowledge engineering. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Satya Ranjan Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, 2nd Edition, 2012.*

2. *Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.*

REFERENCES

1. *K.S. Fu, R.C. Gonzalez, C.S.G. Lee,"Robotics: Control, Sensing, Vision and Intelligence", Tata McGraw-Hill, Eleventh reprint, 2013.*

2. *Robin.R.Murphy, "Introduction to AI Robotics", The MIT Press, Canbridge, Massachusetts, London, England, Second Edition, 2019.*

3. *Jadran Lenarcic, Jean-Pierre Merlet, "Advances in Robot Kinematics 2016", Springer International Publishing AG, 2018.*

4. *Peter McKinnon, "Robotics", CreateSpace Independent Publishing Platform, 2016.*

5. *David. L. Pool and Alan. K. Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University, 2011.*

19ECE33 - REAL TIME CONTROLLERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the concepts and compare the characteristics of real - time systems to choose the architecture of a Real time Controller for an application.*

CO2 : *Infer the architecture and Instruction set of C2000 Processor to develop Assembly language programs*

CO3 : *Appraise the data format, Addressing modes, Pipelining and Interrupt handler of C2000 processor for real time constraints*

CO4 : *Determine the concepts of Energy estimation techniques in Real time Systems*

CO5 : *Examine the communication protocols for real time applications*

REAL TIME ENVIORMENT

Real Time Systems -Types of Real Time systems - Hard and Soft, Real Time Event Characteristics, Challenges in Real Time System Design - Distributed and Multi-processor Architecture - Embedded systems and its characteristics. **(9)**

ARCHITECTURE OF TI C2000

Software Development and the Process - Assembler Directives - C2000 Architecture - Central Processing Unit - Program Control - Programming and System Issues - Phase Locked Loop Application. **(9)**

DEPLOYMENT CONSIDERATIONS

Data Representation and Arithmetic - Fixed Point vs Floating Point Format - Finite Word Length Effects - Addressing Modes - Pipeline - Instruction Cache - Interrupts - Hardware and Software - Real Time Implementation Considerations. **(9)**

ENERGY EFFICIENT REAL TIME SYSTEMS

Basic Concepts of Energy Efficiency and its Estimates - Thermal Effects - Reliability - Hardware Techniques - Power Reduction - Low Power Design - Power Gating - Real Time - Execution Time - Software Techniques- Software Tools - Energy Sources - Batteries - Energy Harvesting. **(9)**

REAL TIME COMMUNICATION

Communication Requirements - Timeliness - Dependability - Design Issues - Flow Control and Thrashing - Event Triggered Communication - Ethernet - Controller Area Network - User Datagram Protocol - Token Protocol - Time triggered communication - Flexray - Control Law Accelerators - Fixed Point Libraries (iQMath). **(9)**

TOTAL : 45

TEXT BOOKS

1. *Hermann Kopetz , "Real Time Systems: Design Principles for Distributed Embedded Applications", Springer publications, 2nd Edition, 2011*

2. *Sen M Kuo and WoongSenGan, "Digital Signal Processors, Architecture, Implementations and Applications", Prentice Hall,1st Edition, 2004.*

REFERENCES

1. *Robert Oshana,"DSP Software Development Techniques for Embedded and Real-Time Systems",Newnes publication,1st Edition, 2006.*

2. *Liv, "Real-Time Systems", Pearson Education, 1st Edition, 2000.*

3. *C2000 Teaching CD ROM from Texas Instruments.*

4. *TMS320C28x CPU and Instruction Set Reference Guide, TI Literature Number: SPRU 430E, Revised January 2009.*

5. *TMS320x28xx, 28xxx DSP Peripheral Reference Guide, TI Literature Number: SPRU566J, Revised April 2011.*

19ECE34 - REAL TIME MICROCOMPUTER SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate the concepts of Real time systems and choose scheduling algorithms to develop Real time systems*

CO2 : *Interpret the programming languages and tools to develop application software for Real time systems*

CO3 : *Determine the concepts of database techniques in Real time systems*

CO4 : *Examine the fault tolerance techniques for Real time applications*

CO5 : *Exemplify the evaluation techniques for fault tolerance in Real time systems*

REAL TIME SYSTEMS

Introduction- Issues in Real Time Computing - Structure of a Real Time System - Task classes - Performance measures for Real TimeSystems - Estimating program run times - Task assignment and scheduling - Classical uniprocessor scheduling algorithms -Uniprocessor scheduling of IRIS tasks - Task assignment - Mode changes and Fault Tolerant Scheduling **(9)**

PROGRAMMING LANGUAGES AND TOOLS

Introduction - Desired language characteristics - Data typing - Control structures - Facilitating Hierarchicaldecomposition - Packages - Run time error handling - Overloading and Generics - Multitasking - Low level programming - TaskScheduling - Timing Specifications - Programming Environments - Run - time support **(9)**

REAL TIME DATABASES

Basic Definitions - Real time Vs General Purpose Databases - Main Memory Databases - Transactionpriorities- Transaction Aborts - Concurrency control issues - Disk Scheduling Algorithms - Two - phase Approach to improvePredictability - Maintaining Serialization Consistency - Databases for Hard Real Time Systems. **(9)**

REAL TIME COMMUNICATION

Communications media - Network Topologies - Protocols - Fault Tolerant Routing - Fault ToleranceTechniques - Fault Types - Fault Detection - Fault Error containment Redundancy - Data Diversity - Reversal Checks - Integrated failure handling **(9)**

RELIABILTY EVALUATION TECHNIQUES

Introduction-Obtaining parameter values, Reliability models for Hardware Redundancy - Software error models- Clock Synchronization - Clocks, - A Nonfault - Tolerant Synchronization Algorithm - Impact of faults - Fault Tolerant Synchronization in Hardware & software. **(9)**

TOTAL : 45

TEXT BOOKS

1. *C.M. Krishna, Kang G. Shin, "Real - Time Systems", Tata McGraw Hill International Editions, 1st Edition, 2010.*

2. *Rajib Mall, "Real-time systems: theory and practice", Pearson Education, 1st Edition, 2008.*

REFERENCES

1. *Peter D.Lawrence, "Real Time Micro Computer System Design - An Introduction", McGraw Hill, 1st Edition 1988.*

2. *Stuart Bennett, "Real Time Computer Control - An Introduction", Prentice Hall of India, 1st Edition, 1998.*

3. *S.T. Allworth and R.N.Zobel, "Introduction to real time software design", Macmillan, 2nd Edition,1987.*

4. *R.J.A Buhur, D.L Bailey, "An Introduction to Real - Time Systems", Prentice - Hall International, 1st Edition 1999.*

5. *Philip.A.Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 4th Edition, April 2012*

19ECE35 - BIOMEDICAL INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the Physiological signals and transducers used in biomedical engineering.*

CO2 : *Infer the physiological parameters using specific types of meters and analyzers.*

CO3 : *Categorize the different types of electrode systems and find suitable application for the bio electric events.*

CO4 : *Describe the equipment used in medical imaging.*

CO5 : *Determine the type of life assisting devices , explain the different diagnostics and therapeutic techniques for medical applications.*

FUNDAMENTALS OF BIOMEDICAL ENGINEERING

Cell and its structure - Resting and Action Potential - Basic components of a biomedical system- -Physiological signals and transducers - Transducers - selection criteria - Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors. **(9)**

NON ELECTRICAL PARAMETERS MEASUREMENT

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements - spirometer - Photo Plethysmography, Body Plethysmography - Blood Gas analyzers, pH of blood -measurement of blood pCO_2, pO_2, finger-tip oximeter - ESR, GSR measurements. **(9)**

ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS

Electrodes - Limb electrodes -floating electrodes - pregelled disposable electrodes - Micro, needle and surface electrodes - Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - ECG - EEG - EMG - ERG - Lead systems and recording methods - Typical waveforms - Electrical safety in medical environment, shock hazards - leakage current-Instruments for checking safety parameters of biomedical equipments. **(9)**

IMAGING MODALITIES AND ANALYSIS

Radio graphic and fluoroscopic techniques - Computer tomography - MRI - Ultrasonography - Endoscopy - Thermography - Different types of biotelemetry systems - Retinal Imaging - Imaging application in Biometric systems - Analysis of digital images. **(9)**

LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES

Pacemakers - Defibrillators - Ventilators - Nerve and muscle stimulators - Diathermy - Heart - Lung machine -Dialyzers - Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery - Advanced 3D surgical techniques- Orthopedic prostheses fixation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and sons, New York, 4th Edition, 2015.*

2. *Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 3rd Edition, 2014.*

REFERENCES

1. *Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice hall of India, New Delhi, 2nd Edition, 2018.*

2. *John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 4th Edition, 2015.*

3. *Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., "Health Care Systems, Technology and Techniques", Springer, 1st Edition, 2011.*

4. *Ed. Joseph D. Bronzino, "The Biomedical Engineering Hand Book", Boca Raton, CRC Press LLC, 3rd Edition, 2006.*

5. *M.Arumugam, "Bio-Medical Instrumentation", Anuradha Agencies, 2006.*

19ECE36 - POWER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate the static and dynamic characteristics of power semiconductor devices.*

CO2 : *Analyze the performance of phase controlled rectifiers.*

CO3 : *Explain the operation and switching techniques of DC-DC converters*

CO4 : *Apply voltage control and harmonic elimination methods to inverters.*

CO5 : *Explain the operation of AC voltage controllers and cycloconverters.*

POWER SEMICONDUCTOR DEVICES

Power Diodes - Power Transistors-SCR - TRIAC - GTO- Power MOSFET - IGBT - IGCT -Static and Dynamic Characteristics. **(9)**

PHASE CONTROLLED RECTIFIERS

Single Phase Half Controlled Rectifier with R and RL load - Single Phase Full Controlled Rectifier with RL load - Effect of free-wheeling diode - Continuous and Discontinuous Mode of operation - Three phase full converters - Dual converters - Light Dimmer - Excitation system - Solar PV systems. **(10)**

DC TO DC CONVERTERS

Step-down and step-up choppers -Types of choppers-A, B, C, D and E -Switching Mode Regulators - Buck Regulator - BoostRegulator - Buck-Boost Regulator-SMPS- Battery operated vehicles. **(9)**

INVERTERS

Single phase voltage source inverters - Voltage control - Single PWM - Multiple PWM - Sinusoidal PWM - Space Vector Modulation in Three phase inverters - Harmonic reduction - Single phase current source inverters -Induction heating - UPS. **(9)**

AC TO AC CONVERTERS

Single phase and Three phase AC voltage controllers- Integral cycle Control - Sequence control -Single phase cycloconverters - Matrix converters. **(8)**

TOTAL : 45

TEXT BOOKS

1. Muhammad Harunur Rashid, "Power Electronics Devices, Circuits, and Applications"Pearson, Fourth Edition, 2014.

2. P. S. Bimbhra, "Power Electronics"Khanna Publishers, Fifth Edition, 2012.

REFERENCES

1. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, Second Edition, 2014.

2. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics: Converters, Applications, and Design" John Wiley & Sons,Third Edition, 2003.

3. VedamSubramanyam, "Power Electronics" New Age International, Second Edition, 2006.

4. M.D.Singh and K.B.Khanchandani, "Power Electronics" Tata McGraw Hills, Second Edition, 2008.

5. Robert W Erickson, "Fundamentals of Power Electronics", 3rd Edition, Springer, 2020.

19EC37 - SENSORS AND TRANSDUCERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the working principles and applications of strain and pressure sensors.*

CO2 : *Categorize the type of motion sensors used for different applications*

CO3 : *Exemplify the working of different types of light radiation sensors .*

CO4 : *Illustrate the key concepts of heat and temperature sensors used to measure the temperature parameters. .*

CO5 : *Explain the construction and working of Electronic sensors.*

STRAIN AND PRESSURE SENSORS

Resistance strain gauge, piezoelectric pressure gauge, characteristics. Electronic circuits for strain gauge, load cells. Interferometry, Fiber optic methods. Pressure gauges: Aneroid capacitance pressure gauge, Ionization gauge, Using the transducers for applications **(9)**

MOTION SENSORS

Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, Rotation sensors drag cup devices, piezoelectric devices. Rotary encoders. **(9)**

LIGHT RADIATION SENSORS

Color temperature, light flux, photo sensors, photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber optic applications, light transducer, solid state, transducers liquid crystal devices. **(9)**

HEAT AND TEMPERATURE SENSORS

Bimetallic strip, Bourdon temperature gauge, thermocouples, Resistance thermometers, thermistors, PTC thermistors, bolometer, Pyroelectric detector. **(9)**

ELECTRONIC SENSORS

Proximity detectors - Inductive and capacitive, ultrasonic, photo beam detectors Reed switch, magnet and Hall-effect units, Doppler detectors, liquid level detectors, flow sensors, smoke sensors. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ernest O Doebelin, Dhanesh N Manik, "Measurement Systems, Application and Design", McGraw Hill, 6th Edition, 2007*

2. *R Sinclair, "Sensors and Transducers, 3rd Edition, Newnes publishers, 2001.*

REFERENCES

1. *Jack P Holman,"Experimental Methods for Engineers", 7th Edition, McGraw Hill, USA, 2001.*

2. *Robert G Seippel, "Transducers, Sensors and Detectors", Reston Publishing Company, USA, 1983.*

3. *Jacob Fraden," Handbook of modern sensors: physics, designs, and applications", 5th Edition, Springer, 2016.*

4. *John P. Bentley," Principles of Measurement systems", 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.*

5. *D. Patranabis," Sensors and Transducers", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.*

19ECE38 - BIOMEDICAL TRANSDUCERS AND BIOSENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the principles of resistive transducers , blood pressure transducers , Capacitive transducers , inductive transducers and their applications.

CO2 : Explain the principles of temperature transducers and Piezoelectric transducers and their applications.

CO3 : Explain the principles of different types of pressure transducers.

CO4 : Explain the principle of biopotential electrodes.

CO5 : Explain the principle of Biosensors and their applications

RESISTIVE AND DISPLACEMENT TRANSDUCERS:

Principle of resistive Strain Gauge, Type and construction of metal wire and Metal foil strain gauges, Strain gauge materials, Gauge factor, Semiconductor strain gauge, Signal Conditioning circuit, Temperature compensation, Bridgebalance circuit, Strain Gauge type Blood pressure transducers. Potentiometric Transducers: L.V.D.T, Inductive displacement transducer, Capacitive displacement transducers, Ultrasonic methods, Diaphragm displacement transducer, Applications.   **(10)**

TEMPERATURE AND PIEZOELECTRIC TRANSDUCERS:

Measurement Principle, characteristics, Design and Applications: Thermosensitive- Resistance Temperature Detectors (RTDs), Thermistor. Thermoelectric -Thermocouple, PN junction diode. Non-contact type temperature measurements techniques: Radiation thermography, Infrared radiation, pyrometer, Infrared temperature probe, Optical Pyrometer.

Piezoelectric phenomena and materials, Output voltage of Piezocrystal, Piezoelectric Force transducer, Piezoelectric acceleration transducer ,Equivalent circuit of Piezoelectric transducers and Dynamic characteristics.Merits and demerits of Piezoelectric Transducers.Piezoelectric UltrasonicTransducer: Construction and design, Electrical excitation, piezoelectric semiconductor and Applications.   **(10)**

PRESSURE TRANSDUCERS:

Occlusive cuff methods- Force balance methods- Direct hydraulically Coupled Catheter transducer system, Diaphragm pressure transducers.-Piezoelectric Pressure transducer-Electrical transduction methods for Catheter tip transducer-Optical transducers.-Implantable pressure transducer, Micro pressure transducer.   **(8)**

BIOPOTENTIAL ELECTRODES

Electrode theory: the electrode / Electrolyte interface, Polarizable and nonpolarizable electrodes, Liquid junction potential, Electrode potential, Application of Biopotential electrodes. ECG electrodes: Surface electrodes, Silver- silver chloride electrodes, stainless steel electrodes, Electrode impedance and Electrode equivalent circuit. EMG electrodes: Surface electrodes, Needle and Wire electrodes. EEG electrodes: Micro and suction electrodes- Glass microelectrodes, Metalmicroelectrodes, Suction electrodes, Microelectrode equivalent circuit.   **(9)**

BIOSENSORS

Definition of biosensor, Application and origin of biosensor, Transduction mechanism of biosensor, Blood gas and pH sensors, Bio-Analytical Sensor, Enzymatic biosensors, Optical Biosensors, PO_2 and PCO_2 sensor .   **(8)**

TOTAL : 45

TEXT BOOKS

1.   *Medical Instrumentation: Application and Design, 5th Edition, John G. Webster (Editor), Amit J. Nimunkar (Editor),ISBN: 978-1-119-45733-6 August 2020.*

2.   *Biomedical Sensors: Fundamentals and Applications, Harry N. Norton, Park Ridge, N.J. Noyes Publications, 1982.*

REFERENCES

1.   *Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, CRC Press, 1997.*

2.   *Transducers for Biomedical Measurements: Principles and Applications, Richard Cobbold (S. C.) Wiley, 1974.*

3.   *Earnest O.Doeblin, Measurement System Application and Design, McGraw Hill Newyork, 1990.*

4.   *Principles of Applied Biomedical Instrumentation, 3rd Edition, L. A. Geddes, L. E. Baker, Wiley, 1991.*

5.   *Biomedical Sensors, Deric P. Jones, Momentum Press, 2010.*

19ECE39 - NANO ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the concepts of diverse Electron microscopes based on their construction techniques.*

CO2 : *Infer the formation and properties of nanotube and identify the appropriate structure of nanotubes for memory application.*

CO3 : *Infer the concepts of Quantum physics, Quantum electronic devices and apply them in Quantum computers.*

CO4 : *Illustrate the features of diverse Logic devices and reconstruct the single electron device for logic applications.*

CO5 : *Use nanobio sensors and develop sensor based medical devices*

BACKGROUND TO NANOTECHNOLOGY

Types of nanotechnology and nano machines - Periodic table - Atomic structure - Molecules and phases - energy - Molecular and atomic size - Surface and dimensional space - Top down and bottom up - Molecular nanotechnology: Electron microscope - scanning electron microscope - Atomic force microscope - Scanning tunnelling microscope-Nano materials - Preparation - Plasma arcing - Chemical vapour deposition - sol-gels - Electro deposition - Ball milling -Applications of nanomaterials. **(9)**

CARBON NANOTUBES

New forms of carbon-Fullerenes - Types of nanotubes - Formation of nanotubes - Assemblies -Electronic properties - Synthesis of carbon nanotubes - Carbon nanotube FETs - Nanotube for memory applications - Prospects of carbon nanotube in Nano electronics. **(9)**

FUNDAMENTALS OF NANO ELECTRONICS

The tool of Micro and nano fabrication-From classical to Quantum physics- Quantum electronic devices-Quantum information and Quantum computers-Experimental Implementations of Quantum Computers. **(9)**

LOGIC DEVICES

Silicon MOSFETS novel materials and alternate concepts-Fundamentals of MOSFET Devices- Nano Electromechanical Logic gates-Single electron devices for Logic applications-Electron wave guide devices-Super conductor Digital electronics. **(9)**

EVOLVING INTERFACES OF NANO

Applications of Nano in Biology: Nano Sensors: Nano scale organization for sensors, Nano Bio Sensors - Nano Medicine: Nano Technology in diagnostic applications, approach to Developing Nano Medicines. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons and BurkhardRaguse, "Nanotechnology: Basic Science and Emerging Technologies", Chapman & Hall / CRC, 2002*

2. *Rainer Waser (Ed.), "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", 3 rdedition, Wiley-VCH, 2012*

REFERENCES

1. *T. Pradeep, "NANO: The Essentials - Understanding Nanoscience and Nanotechnology", McGraw Hill, 2007.*

2. *George W. Hanson, "Fundamentals of Nano electronics", 1st edition, Pearson Educationl, 2008.*

3. *Shunrioda, David Ferry, "Silicon Nano electronics", Taylor and Francis group, CRC 2005.*

4. *Karl Goser, Peter Glosekotter, Jan Dienstuhl, "Nano electronics and Nano system: From transistors to molecular and quantum Devices", Springer 2004.*

5. *Shubra Singh, "Nanoscience and Nanotechnology : Fundamentals of Frontiers", Wiley, 2013.*

19ECE40 - NANO SENSORS AND DEVICES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Illustrate the concepts of characteristics and the classification of nano sensor.*

CO2 : *Infer the material properties and the classification of nanostructured materials.*

CO3 : *Describe the different types of biosensors based on nanostructured materials.*

CO4 : *Describe the different types of chemical based nano sensors.*

CO5 : *Discuss about the microscopic techniques to view nanomaterials and future trends of nano sensors.*

NANO SENSORS

Nanoscience and Nanotechnology Definition of Sensor Parameters and Characteristics Evolution of Semiconductor-Based Micro sensors Definition and Classification of Nano sensors, Examples of Nano sensors. **(9)**

MATERIALS FOR NANO SENSORS

One-dimensional, Two-dimensional and Three-dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties. **(9)**

NANO BIOSENSORS

Introduction, Nanoparticle -Based Electrochemical Biosensors, CNT-Based Electrochemical Biosensors Functionalization of CNTs for Biosensor, Nanotube and Nanowire-Based FET Nano biosensors Fabrication Cantilever- Based Nano biosensors. **(9)**

CHEMICAL NANO SENSORS

Introduction, Gas Sensors-Based on Nanomaterials, Metallic Nanoparticle-Based Gas Sensors, Metal Oxide Gas Sensors, CNT- Nanowire and Opto - chemical Nano sensors, Carbon Nanotube Gas Sensors. **(9)**

FUTURE TRENDS OF NANO SENSORS

Scanning Tunnelling Microscope, Atomic Force Microscope, Mechanical Nano sensors, Thermal Nano sensors, Optical Nano sensors, Magnetic Nano sensors. **(9)**

TOTAL: 45

TEXT BOOKS

1. *Pradeep T, "Nano: The Essentials Understanding Nanoscience and Nanotechnology", Tata Mc-Graw Hill, New Delhi, 2008.*

2. *Ramachandra Rao M S and Shubra Singh, "Nanoscience and Nanotechnology: Fundamentals to Frontiers", Wiley, Delhi, 2017.*

REFERENCES

1. *Vinod Kumar Khanna, "Nanosensors: Physical, Chemical, and Biological", 2nd Edition, CRC Press, 2021.*

2. *Brain, R. Eggins, "Chemical Sensors and Biosensors", Wiley, New York, Chichester, 2008.*

3. *Masaru Kuno, "Introductory Nanoscience: Physical and Chemical Concepts", CRC Press, 2012.*

4. *Hornyak G L, Tibbals H F and Dutta J, "Introduction to Nanoscience and Nanotechnology", Taylor and Francis, 2009.*

5. *Cass A.E.G., Janatha M. Cooper, "Biosensors A Practical Approach", Oxford University Press, 2004.*

19ECE41 - VERILOG HDL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand about the design methodologies in Verilog HDL*

CO2 : *Design various combinational circuits using gate level modeling*

CO3 : *Design combinational circuits using data flow level modeling*

CO4 : *Understand about the design of combinational circuits using behavioral modeling*

CO5 : *Verify and design the digital circuits using switch level modeling*

OVERVIEW OF DIGITAL DESIGN WITH VERILOG HDL

Evolution of Computer Aided Digital Design and Emergence of HDLs - Typical Design flow - Importance of HDLs - Popularity of Verilog HDL - Hierarchical Modeling Concepts: Design Methodologies - 4 bit Ripple Carry Counter - Modules - Instances - Components of a Simulation. **(9)**

GATE LEVEL MODELING

Basic Concepts: Lexical Conventions - Data types - System Tasks and Compiler - Modules - Ports - Gate Types: AND Gate, OR Gate, Buffer, Not Gate - Multiplexer - 4 bit Full Adder - Gate Delays: Rise, Fall, Turn off Delays, Minimum, Typical, Maximum Delays - Delay Examples. **(9)**

DATA FLOW MODELING

Continuous Assignments: Implicit Continuous Assignment - Delays: Regular Assignment Delay, Implicit Continuous Assignment Delay, Net Declaration Delay - Expressions, Operators and Operands - Operator Types - Operator Precedence - 4 to1 Multiplexer - 4 bit Full Adder - Ripple Counter. **(9)**

BEHAVIOURAL MODELING

Structured Procedures - Procedural Assignments - Timing Controls - Conditional Statements - Multiway Branching - Loops - Sequential and Parallel Blocks - 4 to 1 Multiplexer - 4 bit Counters - Traffic Signal Controller. **(9)**

TASKS, FUNCTIONS AND SWITCH LEVEL MODELING

Tasks - Functions - Differences between Tasks and Functions - Switch Level Modeling: Switch Level Modeling Elements - MOS Switches - CMOS Switches - Bidirectional Switches - Power and Ground - Resistive Switches - Delay Specification on Switches - CMOS NOR gate - 2 to 1 Multiplexer - Simple CMOS Flip Flop. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Samir Palnitkar "Verilog HDL - A Guide to Digital Design and Synthesis", Pearson Education, 2nd Edition, 2011*

2. *Stephen D. M. Brown, Zvonko G. Vranesic," Fundamentals of Digital Logic with Verilog Design", McGraw Hill Higher Education, 2nd Edition, 2008*

REFERENCES

1. *T.R. Padmanabhan, B.Bala Tripura Sundari," Design Through Verilog HDL", John Wiley & Sons, 2016.*

2. *Donald E. Thomas, Philip R. Moorby, "The Verilog Hardware Description Language", Springer Science+Business Media, LLC, 5th Edition, 2002.*

3. *Michael D Ciletti,"Advanced Digital Design with the Verilog HDL", Pearson (Prentice Hall), 2nd Edition, 2009.*

4. *J. Bhasker, "Verilog HDL Synthesis - A Practical Primes", Star Galaxy Publishing, 2018.*

5. *Z. Navabi, "Verilog Digital System Designs", Mc Graw Hill, 2nd Edition, 2005.*

19ECE42 - HDL BASED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Design basic combinational and sequential circuits using VHDL*

CO2 : *Design and write VHDL code for carry look ahead adder, binary multiplier and dividers using state graphs*

CO3 : *Design and develop VHDL codes for digital circuits using State Machine charts*

CO4 : *Understand the representation of floating-point number, perform floating point addition and multiplication*

CO5 : *Design and write VHDL code for static RAM memory and a RISC microprocessor*

DESIGN OF BASIC COMBINATIONAL AND SEQUENTIAL CIRCUITS

Design of adder, subtractor, multiplexer, de-multiplexer, encoder, decoder, flip-flops, counters using VHDL. **(9)**

DESIGN OF SUBSYSTEMS FOR ARITHMETIC OPERATIONS

Design of Carry look ahead adder - State graphs for control networks- Design of a binary multiplier-Multiplication of signed binary numbers-Design of a binary divider. **(9)**

DIGITAL DESIGN WITH SM CHARTS

State machine charts- Derivation of SM Charts- Realization of SM Charts-Implementation of the dice game-Alternative Realizations for SM Charts using microprogramming- Linked State Machines. **(9)**

FLOATING POINT ARITHMETIC

Representation of Floating-Point Numbers - Floating Point Multiplication - Floating Point Addition. **(9)**

DESIGN OF MEMORIES AND RISC MICROPROCESSOR

Static RAM Memory- MIPS ISA: Arithmetic Instructions, Logical Instructions, Memory access Instructions, Control Transfer Instructions - Design of Data Path - Instruction Execution Flow - VHDL model for register file, memory, CPU Processor, Complete MIPS. **(9)**

TOTAL:45

TEXT BOOKS

1. *Charles H.Roth, Lizy Kurian John "Digital Systems Design using VHDL", 2nd Edition Cengage Learning, 2013.*

2. *Charles H. Roth, Lizy Kurian John," Principles of Digital Systems Design using VHDL", Cenage Learning India Pvt Ltd, 2010.*

REFERENCES

1. *Douglas L. Perry, "VHDL Programming by example", 4th Edition, McGraw-Hill Education, 2002.*

2. *Stephen Brown, Zvonko Vranesic, "Digital system Design Using VHDL",3rd Edition, Tata Mc Graw Hill, 2009.*

3. *J.Basker, "A VHDL Primer", Addison Wesley, New Delhi, 3rd Edition, 2015.*

4. *Zainalabedin Navabi, "VHDL: Modular Design and Synthesis of Cores and Systems", 3rd Edition, McGraw Hill Education, 2010.*

5. *Volnei A. Pedroni, "Circuit Design with VHDL", MIT Press, 2004.*

19ECE43 - INTRODUCTION TO MINIATURIZATION TECHNOLOGIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the concepts of micro electro mechanical systems and the working principle of MEMS systems.*

CO2 : *Infer the material properties and the fabrication process of microsystems.*

CO3 : *Infer the properties and the classification of nanostructure devices.*

CO4 : *Describe the different methods of synthesis and the characterization of nanomaterials.*

CO5 : *Describe CAD tools and micro, nano based applications for medicine, agriculture and bio-technology and robotics.*

MEMS SYSTEMS

MEMS and Microsystems, Miniaturization, Scaling Laws in Miniaturization , Typical products, MEMS Process, , MEMS materials, Working principle: Micro sensors, MEMS with micro actuators, Micro accelerometers and Micro fluidics. **(9)**

MICROSYSTEM DESIGN MECHANICS, MATERIAL AND FABRICATION PROCESS

Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Microsystem Materials, Microsystem Fabrication Process. **(9)**

NANO SCIENCE AND NANOTECHNOLOGY

Nano science concepts, size effects, surface area, surface to volume ratio, top down and bottom up approach, properties of nanomaterials, Classification of nanostructures: Classification based on dimensionality, Carbon nanotubes and graphene Quantum dots , wells and wires, Carbon-based Nano materials - fullerenes and buck balls **(9)**

SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS

Synthesis of nanomaterials, Chemical Methods: Sol - gel- Chemical Vapour deposition(CVD) - Metal Oxide Chemical Vapour Deposition (MOCVD), Physical Methods: Ball Milling - spray Pyrolysis - Sputtering - Molecular Beam Epitaxy-Characterization of nanostructures : structural characterization, Scanning Electron Microscopy (SEM)- Transmission Electron Microscope(TEM) - Scanning Tunnelling Microscope (STM) - Atomic force microscopy (AFM). **(9)**

MICRO,NANO TOOLS AND APPLICATIONS

CAD TOOLS,BIO-MEMS, MOEMS, Magnetic MEMS, RF Mems, case study - Capacitive RF MEMS switch performance issues, Nanotechnology in agriculture, Nano medicine and Nano biotechnology, nanomaterials for data storage, Case study on Nanorobotics in surgery. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Tai Ran Hsu, MEMS and Microsystems, Design, Manufacture and Nanoscale Engineering, John Wiley & Sons, New Jersey, 2020.*

2. *Stephen D Senturia,"Microsystems Design", Kluwer publishers, 2001.*

REFERENCES

1. *James J Allen, "Micro Electro Mechanical System Design CRC Press-Taylor & Francis", New York, 2005.*

2. *Pradeep T., A Textbook of Nanoscience and Nanotechnology, Tata McGrawHill Education Pvt. Ltd., 2012.*

3. *Charles P.Poole, Introduction to Nanotechnology, Frank J. Owens, Wiley Interscience(2003).*

4. *Mohomed Gad-el-Hak, "The Mems Hand book - application", 2nd Edition, 2006.*

5. *Vijay K Vasadan, K.J. Vinoy, K.A. Jose, "RF MEMS" & Application by John Wiley & Sons Ltd., April 2003.*

19ECE44 - MEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Develop the MEMS and Microsystems using fabrication, sensing and actuation mechanisms.*

CO2 : *Design the MEMS goods by using elasticity, stress ,strain and material properties.*

CO3 : *Analyze the characteristics of electrostatic and electromagnetic for designing actuators and motors.*

CO4 : *Examine the concepts of issues in MEMS circuits and systems and to model and devise the CAD for MEMS*

CO5 : *Determine the design conceptions for RF and optical MEMS applications*

INTRODUCTION TO MEMS

MEMS and Micro systems - Miniaturization - Typical products - Micro sensors - Micro actuation- MEMS with micro actuators-Micro accelerometers - Micro Fluidics - MEMS materials - Micro fabrication **(9)**

MECHANICS FOR MEMS DESIGN

Elasticity: Stress, Strain and material properties - Bending of thin plates - Spring configurations - Torsional deflection - Mechanical Vibration: Resonance - Thermo mechanics - Actuators - Force and response time - Fracture and thin film mechanics. **(9)**

ELECTROSTATIC AND ELECTROMAGNETIC DESIGN AND SYSTEM ISSUES

Electrostatics : Basic theory, Electro Static Instability - Surface Tension-Gap and finger pull up - Electro static actuators - Comb generators - Gap closer - Rotary motors - Inch worms - Electromagnetic actuators - Bistable actuators - Electronic interfaces - Feedback system - Noise - Circuit and system issues. **(9)**

MEMS APPLICATION

Case studies - Capacitive accelerometer - Piezo Electric pressure sensor - Micro fluidics application -Modeling of MEMS Systems - CAD for MEMS. **(9)**

INTRODUCTION TO OPTICAL AND RF MEMS

Optical MEMS - System design basics: Gaussian optics, Matrix operations, Resolution - Case studies - MEMS Scanners and Retinal Scanning display - Digital Micro Mirror Devices - Optical switches -RF MEMS: Design basics, Case study, capacitive RF MEMS switch, Performance issues. **(9)**

TOTAL : 45

TEXT BOOKS

1. *MEMS and Microsystems : Design, Manufacturer and Nanoscale Engineering, Wiley By Tai Ran Hsu, 2020.*

2. *Stephen Senturia, "Micro systems design", Kluwer publishers, 2001.*

REFERENCES

1. *Vijay K. Varadan, K.J. Vinoy, K.A.Jose, "RF MEMS" and their Application" Published by John Wiley & sons Ltd, England, reprinted April 2003.*

2. *NadimMaluf and Kirt William, "An introduction to Micro Electromechanical system Engineering", 2nd Edition, Artech House, 2004.*

3. *Mohamed Gad-el-Hak, "The MEMS Hand book-Application", CRC press, 2nd Edition,2006*

4. *Tai Ran Hsu, "MEMS & Micro systems Design, Manufacture and Nano scale Engineering" John Wiley and sons, New Jersey, 2nd Edition, 2008.*

5. *Jan G. Korvink, Oliver Paul, "MEMS a practical guide of design, analysis and applications", William Andrew, 2006.*

19ECE45 - VLSI PROCESS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand the physics of Crystal growth, wafer fabrication and basic properties of silicon wafer.

CO2 : Infer the concepts of various lithography and etching techniques.

CO3 : Describe the different process of wafer exposure system.

CO4 : Describe the process of IC fabrication technology.

CO5 : Discuss about the analytical, assembly and packaging techniques of VLSI devices.

CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY AND OXIDATION

Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing considerations, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Oxidation Techniques and Systems. **(9)**

LITHOGRAPHY AND RELATIVE PLASMA ETCHING

Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, reactive Plasma Etching techniques and equipments. **(9)**

DEPOSITION, DIFFUSION, ION IMPLEMENTATION AND METALLIZATION

Deposition process, Poly silicon, plasma assisted Deposition, CVD-Diffusion-Models of Diffusion in Solids, Fick's one dimensional Diffusion Equations - Atomic Diffusion Mechanism - Measurement techniques -Van der-pauw technique -Ion implantation - Physical vapor deposition - deposition methods. **(9)**

PROCESS SIMULATION AND VLSI PROCESS INTEGRATION

CMOS IC process Technology - Diffusion and oxidation - Epitaxy - Lithography - Etching and Deposition- NMOS IC process Technology -- MOS Memory IC technology - Bipolar IC Technology - IC Fabrication. **(9)**

ANALYTICAL, ASSEMBLY TECHNIQUES AND PACKAGING OF VLSI DEVICES

Analytical Beams - Chemical methods - Package types - packaging design considerations - VLSI assembly technology - Package fabrication technology. **(9)**

TOTAL : 45

TEXT BOOKS

1. S.M.Sze, "VLSI Technology", McGraw Hill Education; 2nd edition, 2017.
2. Gary S. May and Costas J. Spanos," Fundamentals of semiconductor manufacturing and process control", John Wiley and Sons, 2006.

REFERENCES

1. Wai Kai Chen, "VLSI Technology" CRC Press, 2003.
2. Hong Xiao, "Introduction to Semiconductor Manufacturing Technology",PHI,2001.
3. James D Plummer, Michael D. Deal, Peter B. Griffin, "Silicon VLSI Technology: Fundamentals Practice and Modeling", Prentice Hall India.2000.
4. Amar Mukherjee, "Introduction to NMOS and CMOS VLSI System design:Prentice Hall India.2000.
5. Gary S. May, S.M. Sze, "Fundamentals of Semi conductor Fabrication", John Wiley and Sons, 2004.

19ECE46 - LOW POWER VLSI DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the sources of power dissipation in CMOS*

CO2 : *Summarize the power optimization and trade-off techniques in digital circuits*

CO3 : *Learn how to design low power memories and special techniques*

CO4 : *Illustrate the power estimation at logic and circuit level*

C05 : *Explain the software design for low power in various level*

POWER DISSIPATION IN CMOS

Hierarchy of limits of power - Sources of power consumption - Physics of power dissipation in CMOS FET devices - Basic principle of low power design **(9)**

POWER OPTIMIZATION

Logical level power optimization - Circuit level low power design - Circuit techniques for reducing power consumption in Adders and Multipliers **(9)**

DESIGN OF LOW POWER CMOS CIRCUITS

Computer Arithmetic techniques for low power systems - Reducing power consumption in memories - Low power clock- Interconnect and layout design - Advanced techniques - Special techniques **(9)**

POWER ESTIMATION

Power estimation techniques - Logic level power estimation - Simulation power analysis - Probabilistic power analysis **(9)**

SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER

Synthesis for low power -Behavioral level transforms - Software design for low power **(9)**

TOTAL : 45

TEXT BOOKS

1. *K.Roy and S.C. Prasad, "Low power CMOS VLSI circuit design", Wiley 2014.*

2. *Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998*

REFERENCES

1. *Kiat-send Yeo, Kaushik Roy "Low-Voltage, Low-power VLSI Subsystem", Tata McGrawHill, 2009.*

2. *Abdellatif Bellaouar, Mohamed. I. and Elmasry, "Low power digital VLSI design", Kluwer, 2008*

3. *Dimitrios Soudris, Chirstian Pignet and Costas Goutis, "Designing CMOS circuits For Low Power", Kluwer, 2002.*

4. *James B.Kulo, Shih-Chia Lin, "Low voltage SOI CMOS VLSI devices and Circuits", John Wiley and sons, inc. 2001*

5. *A.P.Chandrasekaran and R.W.Broadersen, "Low power digital CMOS design",Kluwer,1995*

19ECE47 - IC FABRICATION TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the basic IC fabrication, cleaning and etching process.*

CO2 : *Explain the different methods of epitaxy and oxidation*

CO3 : *Explain metal and non-metal deposition and plasma, RIE & RTP etching techniques*

CO4 : *Analyze the different methods of lithography and diffusion*

CO5 : *Explain implantation equipment, annealing & shallow junctions and NMOS, CMOS technologies*

IC TECHNOLOGY FUNDAMENTALS

Basic Fabrication Steps and their Importance - Clean Room and Safety Requirements - Wafer Cleaning Processes - Wet Chemical Etching Techniques - Electronic Grade Silicon - Czochralski Crystal Growing - Silicon Shaping - Processing Considerations.

(9)

EPITAXY AND OXIDATION

Epitaxy: Vapor Phase Epitaxy - Molecular Beam Epitaxy - Silicon on Insulators - Epitaxial evaluation - Oxidation: Growth mechanism and Kinetics - Thin Oxides - Oxidation technologies in VLSI and ULSI - Characterization of Oxide Films - Oxide Properties - Redistribution of Dopants at Interface - Oxidation of Polysilicon - Oxidation Induced Defects   **(9)**

DEPOSITION AND ETCHING

Chemical Vapour Deposition Techniques for deposition of Polysilicon, Silicon Dioxide, Silicon Nitride and Metal Films - Metal Film Deposition - Evaporation and Sputtering techniques - Failure mechanisms in Metal Interconnects - Multi-level Metallization schemes - Plasma and Rapid Thermal Processing - PECVD - Plasma Etching and RIE techniques - RTP techniques for Annealing, Growth and Deposition of various films for use in ULSI.   **(9)**

LITHOGRAPHY AND DIFFUSION

Photolithography - E-Beam Lithography - X-Ray Lithography - Ion Lithography - Mask Generation - Models of Diffusion in Solids - Fick's One Dimensional Diffusion Equations - Atomic Diffusion Mechanisms - Diffusivities of B, P, As and Sb - Measurement techniques - Diffusion in Polysilicon, SiO2 - Diffusion Enhancements and Retardations.   **(9)**

ION IMPLANTATION AND VLSI PROCESS INTEGRATION

Ion implantation: Range theory, implantation equipment, annealing, shallow junctions, high energy implantation. VLSI process integration of NMOS, CMOS and Bipolar Circuits - Advanced MOS technology   **(9)**

TOTAL : 45

TEXT BOOKS

1. *S.M.Sze, "VLSI Technology", 2nd Edition, Tata McGraw-Hill, 2003.*

2. *C.Y. Chang and S.M.Sze, "ULSI Technology", McGraw-Hill, 1996.*

REFERENCES

1. *Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Second Edition, Oxford University Press, 2001.*

2. *James D. Plummer, Michael D. Deal, Peter D.Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", 1st Edition, Pearson Education, 2009.*

3. *Sorab K. Ghandhi, "VLSI Fabrication Principles: Silicon and Gallium Arsenide", 2nd Edition, John & Wiley Sons, 1994.*

4. *Peter R.Shepherd, "Integrated Circuit: Design, Fabrication and Test", McGraw-Hill, 1996.*

5. *Gary S. May, S.M. Sze, "Fundamentals of Semiconductor Fabrication", 1st Edition, John & Wiley Sons, 2004.*

19ECE48 - CMOS ANALOG IC DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Realize the concepts of single stage amplifiers and design*

CO2 : *Analyze the modes of operation of differential amplifiers and current mirrors*

CO3 : *Understand the frequency response and noise characteristics of single stage amplifiers and differential amplifiers followed by loading effect in feedback networks*

CO4 : *Explain single stage and two stage operational amplifiers and its compensation techniques*

CO5 : *Discuss about the switched capacitor filters, oscillators and PLL*

SINGLE STAGE AMPLIFIERS

Importance of Analog Integrated CMOS Circuits-General consideration of MOS devices: MOSFET as a switch, MOSFET structure, I/V Characteristics - Second Order Effects - MOS Device Models- Single Stage Amplifiers: Common source stage with different loads, Source Followers, Common gate stage & Cascode Stage. **(9)**

DIFFERENTIAL AMPLIFIERS AND CURRENT MIRRORS

Single Ended and Differential operation- Qualitative and Quantitive analysis of Differential pair-Common mode response-Differential Pair with MOS loads- Gilbert Cell. Basic current mirrors-Cascode current mirrors- Active current mirrors- Large signal and small signal analysis -Common mode operation. **(9)**

FREQUENCY RESPONSE OF AMPLIFIERS AND NOISE

General Considerations- Miller Effect-Association of poles with nodes- Frequency response of Common source stage with different loads-Source Followers-Common gate stage-Cascode Stage-Differential Pair. Noise- Types of noise- Noise in single stage amplifiers- Noise in differential pairs- Effect of feedback on noise- Effect of loading in feedback networks **(9)**

OPERATIONAL AMPLIFIERS

General Considerations- Performance parameters-One stage and two stage opamps- Gain boosting- Comparison-Common mode feedback-Input range limitations - Slew rate-Power supply rejection- Noise in Opamps. Stability and frequency compensation **(9)**

SWITCHED CAPACITOR CIRCUITS AND PLL

General Considerations- Sampling switches- Switched Capacitor Amplifiers- Switched Capacitor Integrator- Switched Capacitor common mode feedback. Oscillatory system - Ring oscillators -cross coupled LC oscillators - Voltage Controlled Oscillators (VCO) -Phase Locked Loops-Simple PLL- Charge pump PLL - Non ideal effects-Delay locked loops -Applications of PLL. **(9)**

TOTAL : 45

TEXT BOOKS

1. Behzad Razavi "Design of Analog CMOS Integrated Circuits", 2nd Edition, McGraw-Hill Education, 2017.

2. Phillip Allen and Douglas Holmberg "CMOS Analog Circuit Design", 2nd Edition, Oxford University Press, 2016.

REFERENCES

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", 5th Edition, John Wiley & Sons Inc, 2009

2. David A. Johns, Ken Martin, "Analog Integrated Circuit Design", Wiley Student Edition, 2013

3. Alan B.Grebene, "Bipolar and MOS Analog Integrated circuit design", John Wiley & sons, Inc.,Wiley Classics Library Edition, 2002.

4. Neil H.E Weste and Kamran Eshraghian, "Principles of CMOS VLSI Design: A System Perspective", Addison Wesley, NewDelhi, 2nd Edition, 2009.

5. R. Jacob Baker, " CMOS : Circuit Design, Layout and Simulation", Wiley India Pvt. Ltd., 2nd Edition, 2015.

19ECE49 - ELECTROMAGNETIC RADIATION HAZARDS AND SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Interpret the sources of extremely low frequency and radio frequency radiation.*

CO2 : *Explain the biological interaction of Electromagnetic Radiation on human cells and threat to Cancer.*

CO3 : *Analyze the Dosimetry effects of Electromagnetic Radiation using Specific Absorption Rate.*

CO4 : *Describe the safety standards and International Regulations framed for radiation protection.*

CO5 : *Infer the radio frequency survey on Mobile phones, Microwave ovens and Medical devices.*

SOURCES OF ELECTROMAGNETIC RADIATION

Sources of Extremely Low frequency Fields: DC Sources and AC Sources - Electric Utility System - Extremely Low frequency Fields in the Environment -Elements of Radio Frequency Radiation System - Radio and Television Transmitters - Radar Systems - Satellite Earth Stations - Microwave Communications - Mobile Radio Equipment - Cellular Communication - Nano communication Sources. **(9)**

BIOLOGICAL EFFECTS

Interaction Mechanisms - Extremely Low frequency Fields and Cancer - Cellular Studies - Animal Studies - Human Studies - Epidemiological studies of Cancer and Nano cancer - Thermal Effects - Athermal and Nonthermal Effects - Genetic Effects - Cell Proliferation - Cell Transformation. **(9)**

INCIDENT AND INTERNAL FIELD DOSIMETRY

Radio Frequency Radiation Modeling - Measurement Techniques - Time Averaging - Spatial Averaging - Mitigation in Public and Occupational Environments - Specific Absorption Rate - Types - parameters - Estimation of Specific Absorption rate - Theoretical Dosimetry - Experimental Dosimetry - Phantom Models - Dosimetric Studies of Cellular Phones. **(9)**

SAFETY AND REGULATION

Safety Standards - Extremely Low frequency Standards in Europe - Regulations in United States - ANSI/IEEE C95.1 - National Council on Radiation Protection and Measurement - National Institute for Occupational Safety and Health - Regulations in Asia Pacific - International Regulatory Activities: International Radiation Protection Association - International Commission on Non-Ionizing Radiation Protection. **(10)**

RADIO FREQUENCY SITE SURVEYS

Survey on Mobile Systems - Survey of Broadcast Stations - Survey of Traffic Radar Devices - Survey of Radio Frequency Heating Equipment - Microwave Ovens - Survey of Radio Frequency Interference on Medical Devices. **(8)**

TOTAL: 45

TEXT BOOKS

1. *Riadh W.Y. Habash," Electromagnetic Fields and Radiation: Human Bioeffects and Safety"CRC Press, 1st Edition, 2018*

2. *Patrick Staebler," Human Exposure to Electromagnetic Fields: From Extremely Low Frequency (ELF) to Radiofrequency", John Wiley & Sons, 2017.*

REFERENCES

1. *Andrew W. Wood, Ken Karipidis, "Non-ionizing Radiation Protection: Summary of Research and Policy Options", John Wiley & Sons, 2017.*

2. *Colin J. Martin, David G. Sutton, "Practical Radiation Protection in Healthcare", Oxford University Press, 2015.*

3. *Martin Roosli "Epidemiology of Electromagnetic Fields" CRC Press, 1st Edition, 2014.*

4. *Peter Stavroulakis, "Biological Effects of Electromagnetic Fields: Mechanisms, Modeling, Biological Effects, Therapeutic Effects, International Standards, Exposure Criteria" Springer Science & Business Media, 2014.*

5. *Anne Perrin, Martine Souques, "Electromagnetic Fields Enviroment and Health, Springer, 2013.*

19ECE50 - MODERN ANTENNAS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the concept and applications of PIFA, Helical & Ceramic chip antennas and illustrate SAR value measurement & minimization methods for mobile handset.

CO2 : Categorize Fractal structuresand determine the radiation parameters of simple Fractal antenna.

CO3 : Categorize antennas for millimeter wave and sub-millimeter wave applications based on their operating frequency and Explain the concept and radiation parameters of Substrate integrated waveguide,Dielectric resonator,Reflector antennas.

CO4 : Explain the techniques for broad impedance bandwidth & enhanced radiation performance and applications in high speed wireless communication

CO5 : Derive and describe narrowband beam processing techniques for smart antenna such as Conventional, Null steering & Optimal beam former and Optimal beam space processor.

MOBILE HANDESET ANTENNAS

Review of antenna basic parameters - Frequency bands for commercial applications - Cellular handset antenna design issues - Helical wire antennas and variants - Evolution of the PIFA - Ceramic chip and resonator antennas - SAR measurement and minimization - Provision for GPS and Bluetooth. **(9)**

FRACTAL ANTENNAS

Fractal antenna geometries - Iterated function systems - Fractal antenna elements - Radiation characteristics - Fractal antenna arrays - Antenna arrays based on aperiodic tilings - Hybrid Fractal antenna - Fractal MIMO structures. **(9)**

MILLIMETER WAVE ANTENNAS

Millimeter wave and Terahertz applications - Waveguide antennas - Printed planar antennas - On-chip antennas - Sub millimeter wave antennas - Vivaldi antenna & long slot array for ultra-wideband characteristics - Dielectric resonating antennas -Substrate integrated waveguide antennas -Reflector antennas. **(9)**

BROADBAND PLANAR ANTENNA

Suspended plate antennas - Techniques for broad impedance bandwidth - Techniques for enhanced radiation performance - Planar monopole antennas - Applications in high speed wireless communications. **(9)**

SMART ANTENNAS

Beam steering - Degree of freedom - Key benefits of smart antennas technology - Narrow band processing: Signal model-Conventional beam former-Null steering beam former-Optimal beam former-Optimization using reference signal-Optimal beam space processor. **(9)**

TOTAL: 45

TEXT BOOKS

1. John.L.Volakis, "Antenna Engineering Handbook", Tata McGraw Hill, 4th Edition, 2007.
2. Constantine A.Balanis, "Modern Antenna Handbook", John Wiley and Sons, 2008.

REFERENCES

1. S.Drabowitch, A.Papiernik ,et.al, "Modern Antennas", Springer, 2nd Edition,2005.

2. Frank Gross, "Smart Antennas for Wireless Communications", Mc Graw-Hill, 1st Edition 2005.

3. Zhi Ning Chen, "Antennas for Portable Devices", John Wiley & Sons, 2007.

4. Lal Chand Godara, "Smart Antennas", C.R.C Press, 2004.

5. John D Kraus, Ronald J Marhefka, Ahmad S Khan,"Antennas for all applications", John Wiley and Sons, 3rd Edition, New York, 2002.

19ECE51 - ADVANCED ANTENNA TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Comprehensive knowledge of various antennas design and performance parameters of antenna.*

CO2 : *Ability to understand design constraints of smart antennas for different application.*

CO3 : *Understand the basic concept of mobile satellite antennas in Satellite Communication.*

CO4 : *Describe the different design techniques for mobile-phone antennas and implementation of different techniques used for SAR reduction.*

CO5 : *Explain the concept and applications of Spiral antenna, flagpote & ILS antennas and different advance antennas currently in practice.*

LENS ANTENNA

Artificial dielectric lens antenna - Luneburg & Einstein lenses - electrically & physically small antenna - ground plane antenna - sleeve antenna - turnstile antenna - submerged antenna, surface wave & leaky wave antenna - weather-vane antenna **(9)**

SMART ANTENNAS

Antenna arrays - Antenna classification - Diversity techniques - Introduction - Need for smart antennas - Overview - Smart antenna configurations - Space Division Multiple Access - Architecture of a smart antenna system - Mutual coupling effects.

(9)

MOBILE SATELLITE ANTENNAS

Introduction - system requirements for vehicle antennas - omnidirectional antennas for mobile satellite communication - directional antennas for mobile satellite communication - antenna systems for GPS - Multiband antennas for future GPS/ITS services - Satellite constellation systems and antenna requirements. **(9)**

MOBILE HANDESET ANTENNAS

Review of antenna basic parameters - Frequency bands for commercial applications - Cellular handset antenna design issues - Helical wire antennas and variants - Evolution of the PIFA - Ceramic chip and resonator antennas - SAR measurement and minimization - Provision for GPS and Bluetooth. **(9)**

SPECIAL ANTENNAS

Principle of frequency independent antennas -Spiral antenna, Helical antenna, Log periodic- Reconfigurable antenna, Active antenna, Dielectric antennas - flagpote antenna - chimney antenna - ILS antenna - sugar-scoop antenna - asteroid detection antenna - embedded antenna - plasma antenna. **(9)**

TOTAL: 45

TEXT BOOKS

1. *P. J. B. Clarricoats ,"Advanced Antenna Technology", Microwave Exhibitions and Publishers, 2nd Edition,1987.*

2. *Constantine A. Balanis, Panayiotis I. Ioannides, "Introduction to Smart Antennas" Morgan & Claypool Publishers, 1st Edition,2007.*

REFERENCES

1. *Zhi Ning Chen, "Antennas for Portable Devices", John Wiley & Sons, 1st Edition 2007.*

2. *Lal Chand Godara, "Smart Antennas", C.R.C Press, 1st Edition 2004.*

3. *John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for all applications", John Wiley and Sons, 3rd Edition, New York, 2002.*

4. *Frank Gross, "Smart Antennas for Wireless Communications", McGraw-Hill., 1st Edition 2005.*

5. *Kyohei Fujimoto, "Mobile Antenna Systems Handbook", Artech House, 3rd Edition,2008*

19ECE52 - ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain EMI/EMC concepts and its sources*

CO2 : *Explain the various coupling principles and standards*

CO3 : *Describe the various EMI measurement methods and its control techniques*

CO4 : *Describe the performance of EMC design for PCBs.*

CO5 : *Explain the Measurement techniques for emission and about EMC standards.*

EMI ENVIRONMENT

EMI/ EMC concepts and definitions - Electromagnetic environment- Natural and Nuclear sources of EMI: Celestial Electromagnetic Noise, Lightning Discharge, Electrostatic Discharge, Electromagnetic Pulse-EMI from apparatus and circuits: Noise from Relays and Switches. **(9)**

EMI COUPLING PRINCIPLES AND STANDARDS

Conducted, radiated and transient coupling- Common ground impedance coupling - Common mode and ground loop coupling - Differential mode coupling - Near field cable to cable coupling - Field to cable coupling - Power mains and Power supply coupling-Cross talk in transmission lines. **(9)**

EMI CONTROL TECHNIQUES

Shielding- Filtering- Grounding- Electrical Bonding- Isolation Transformer - EMI Suppression Cables- EMC connectors- Transient suppressors and Surge Suppression Devices. **(9)**

EMC DESIGN OF PCBS

Component selection and mounting; Choice of capacitors, inductors, transformers and resistors, Power Distribution Decoupling - Zoning - Motherboard Designs and Propagation Delay Performance Models. **(9)**

EMI MEASUREMENTS AND STANDARDS

Open area test site Measurements-Measurement Precautions-Anechoic Chamber- TEM cell- Reverberating Chamber, GTEM cell- Comparison of test facilities- Civilian standards: CISPR, FCC, EN- Military standards: MIL 461/462. **(9)**

TOTAL:45

TEXT BOOKS

1. *V.P.Kodali, "Engineering EMC principles, Measurements and Technology", IEEE Press, Newyork, Wiley-Blackwell, Second Edition,2016.*

2. *Clayton R. Paul, "Introduction to Electromagnetic Compatibility "John Wiley & Sons,2014.*

REFERNCES

1. *Christos Christopoulos, "Principles and Techniques of Electromagnetic Compatibility", Second Edition, CRC Press, 2018*

2. *Bogdan Adamczyk , ' Foundations of Electromagnetic Compatibility: with Practical, Wiley, 2017*

3. *David A. Weston, "Electromagnetic compability: Methods, Analysis, Circuits and Measurments" Third Edition, CRC Press,2016.*

4. *Henry W.Ott,, "Noise Reduction Techniques in Electronics System", John Wiley and Sons,Newyork,1998.*

5. *Bernhard Keiser, "Principles of Electomagnetic Compatibility", Artech house, 3rd Edition, 1994.*

19ECE53 - RF MICROELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Examine transceiver architecture and analyses RF components for effective transmission and Reception*

CO2 : *Analyze impedance matching issues in Low Noise Amplifiers, mixers and Gilbert Cells.*

CO3 : *Categorize and explain oscillators for RF Signal generation*

CO4 : *Describe Phase detectors, charge pumps and synthesizers and infer stability issues*

CO5 : *Assess the impedance matching issues in power amplifier during large signal power amplification.*

TRANSCEIVER ARCHITECTURES

Heterodyne and Homodyne architectures - Direct conversion Transceiver-Low IF receiver - Discrete and CMOS realization of passive components for RF - Distortion - IP3 - Blockers and Blocker Filtering - Friis Formula for cascaded blocks.   **(9)**

CMOS LNAS AND MIXERS

Noise Figure and impedance matching issues -Common Source Amplifier - Common Gate Amplifier and differential LNAs - Passive mixers - Active mixers - Gilbert cells - linearity and Noise Figure of mixers.   **(9)**

OSCILLATORS

LC Resonator-Analysis of Oscillator as Feedback System-Negative Resistance generated by amplifier - Basic differential oscillator topologies - Modified Common-Collector Colpitts' Oscillator with Buffering-Phase Noise.   **(9)**

FREQUENCY SYNTHESIS

PLL Components-Continuous Time Analysis for PLL Synthesizers-Discrete Time Analysis for PLL Synthesizers-Transient Behavior of PLLs-Fractional-N PLL Frequency Synthesizers.   **(9)**

POWER AMPLIFIERS

Class A, B , C , D , E ,F and AB power amplifiers - Summary of Amplifier classes for RF Integrated Circuits -Matching to achieve desired power- Effects and Implication of Non- Linearity.   **(9)**

TOTAL: 45

TEXT BOOKS

1. *John Rogers and Calvin Plett, "Radio Frequency Integrated Circuit Design", Artech House, 2nd Edition ,2010.*

2. *B. Razavi - "RF Microelectronics" - Pearson Education, 2nd Edition, 2012.*

REFERENCES

1. *Ken Kuang, Franklin Kim, Sean S. Cahill, "RF and Microwave Microelectronics Packaging", Springer New York, 2009.*

2. *Serge Luryi, Jimmy Xu, Alex Zaslavsky, "Future Trends in Microelectronics: Up the Nano Creek", John Wiley & sons, 3rd Edition, 2007.*

3. *Marian K. Kazimierczuk ,"RF power amplifiers" Wiley, 2nd Edition ,2014.*

4. *Carlos Quemada, Guillermo Bistue, Inigo Adin, "Design Methodology for RF CMOS phase locked loops", Artech house, 2008.*

5. *Ferri Losee, "RF Systems, Components and Circuits handbook", Artech house, 2nd Edition 2005.*

19ECOC01 - BASICS OF PYTHON

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1   :   Explain basic concepts and illustrate data types, operators, and I/O functions for writing Python Programming

CO2   :   Write Python programs using conditional statements and list and interpret results

INTRODUCTION

Conceptual introduction, topics in computer science, algorithms,modern computer systems, hardware architecture, data representation in computers, software and operating system,installing Python: basic syntax, interactive shell, editing, saving, and running a script,The concept of data types; variables, assignments, immutable variables,numerical types, arithmetic operators and expressions, comments in the program, understanding error messages.   **(7)**

CONTROL STATEMENTS AND LIST

Conditions, boolean logic, logical operators, ranges Control statements: if-else, loops (for, while) String manipulations: subscript operator, indexing, slicing a stringstrings and number system: converting strings to numbers and vice versa , Binary, octal, hexadecimal numbersLists, tuples, and dictionaries basic list operators, replacing, inserting, removing an element- searching and sorting lists Dictionary literals, adding and removing keys, accessing and replacing values-Traversing dictionaries-Case Study.   **(8)**

TOTAL : 15

TEXT BOOK

Fundamentals of Python, First Programs Author, Kenneth Lambert Publisher, Course Technology, Cengage Learning, 2012 ISBN-13: 978-1-111-82270-5.

19ECOC02 - QUANTITATIVE APTITUDE FOR ENGINEERS / VERBAL APTITUDE FOR ENGINEERS

APTITUDE SYLLABUS

QUANTITATIVE

- Time And Work
- Time, Speed, Distance
- Averages
- Ratios & Proportion
- Sequence, Series and Progressions
- Co-Ordinate Geometry
- Statistics
- Combinatorics
- Percentage
- Trigonometry
- Set Theory
- Theory of Equation
- Logarithms
- Functions and Graph
- Data Interpretation on Multiple Charts
- Profit and Loss
- Simple Equations
- Algebra
- Geometry
- Data Interpretion
- Alligations and Mixtures
- Simple Interest & Compound Interest
- Pipes and Cisterns
- Problems on HCF and LCM
- Linear Algebra
- Probability
- Percentages
- Permutations & Combinations
- Numbers
- Functions
- Mensuration
- Sudoku
- Areas Shapes, Perimeter
- Height and Distance
- Partner ship
- Races and Games

- Simplification
- Clocks & Calendars
- Problems on Ages
- Surds & Indices
- Data Sufficiency
- Problems on Trains
- Cryptarithmetic
- Divisibility
- Numbers and Decimal Fractions
- Spatial Ability
- Chain Rule

VERBAL
- Paragraph Formation
- Sentence Completion
- Reading Comprehensions
- Sentence Correction
- Spotting Errors
- Sentence Selection
- Antonyms
- Synonyms
- Theme Detection
- Parts of Speech
- Jumbled Sentences
- Selecting Words
- Sentence Improvement
- Odd Words
- Sentence Formation
- Fact - Inference - Judgement
- Fill in the Blanks
- One Word Substitution
- Idioms and Phrases
- Spellings

19ECOC03 - PROBLEM SOLVING WITH ALGORITHMS AND DATA STRUCTURES

(ONE CREDIT COURSE- LABORATORY)

LIST OF EXPERIMENTS

- Sparse and Dense Matrix operations using arrays
- Implementation and Applications of Linked List- Singly linked, Doubly linked and Circular lists
- Implementation and applications of stacks
- Implementation and application of queues
- Binary search trees and Minimum cost spanning tree
- Graphs - Depth First Search and Breadth First Search
- Sorting algorithms

REFERENCES

1. *Jean Paul Tremblay and Sorenson, An Introduction to Data Structures with Applications, McGraw Hill Publishing Company, New Delhi, 2012.*

2. *Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, MIT Press, England, 2009.*

3. *Venkatesan R and Lovelyn Rose S, Data Structures, Wiley India Pvt Ltd, New Delhi, 2015.*

4. *Laboratory Manual , Prepared by Department , CIT*

19ECOC04 - PROGRAMMING IN C: A PRACTICAL APPROACH

- Data Types, Variables and Constants
- Operators & Expressions
- Input Output statements
- Conditional statements
- Loops
- Arrays
- Pointers with Arrays
- Concepts of Arrays and Pointers. Debugging concepts. Examples.
- Pointers with functions and call types
- Concepts of Functions. Debugging examples.

TOTAL : 15

REFERENCES

1. *Byron S.Gottfried and Jitender Kumar Chhabra, Programming with C, Tata McGraw Hill Publishing Company, 4th Edition, New Delhi, 2018.*
2. *Brian W.Kernigham and Dennis M.Ritchie, C programming Language (ANSI C), Pearson India, 2nd Edition, 2015.*
3. *Herbert Schildt, C-The Complete Reference, Tata McGraw Hill Publishing Company, 4th Edition, New Delhi, 2010.*
4. *PradipDey and ManasGhosh, Programming in C, Oxford University Press, New Delhi, 2nd Edition, 2011.*
5. *Deitel and Deitel, How to Program, Pearson Education, 7th Edition, New Delhi, 2013.*
6. *E. Balaguruswamy, "Programming in ANSI C", Tata McGraw-Hill, 8th Edition, New Delhi, 2019.*

19ECOC05 - PROGRAMMING IN C++

BASICS OF C++ & ABSTRACT DATA TYPE IN C++

Introduction to C++ - Programming Paradigms - Procedural Programming - Conquering Complexity - Built-in Types - Arrays and Pointers - Comments, Keywords & I/O Streams- Built-in Operators and Control Constructs - Structures, References and Functions

Encapsulation: Data Members, Member Functions, Private and Public - Constructors and Destructors: Default Arguments, Storage Allocation and Deallocation, this Pointer, Copy Constructors.   **(7)**

OPERATOR OVERLOADING & POLYMORPHIC PROGRAMMING

Operator functions - Binary and unary operators - Member and non-member operators - Friend functions - Initialization vs. Assignment - Stream Input and Output Inheritance: Public Inheritance and Subtyping, Base and Derived Classes, Constructors and Destructors, Base Class Initialization, Using Protected keyword- Virtual Functions: Base Class Pointers and References - Dynamic Binding: Abstract Base Classes, Pure Virtual Functions & Virtual Destructors -Exceptions: try, catch & throw -Exception Hierarchies - File streams.   **(8)**

TOTAL : 15

REFERENCES

1.   BjarneStroustrup, "The C++ Programming Language", 3rd Edition, Pearson Education, 2000.
2.   Stanley B Lippman, Jove Lajoie, and Barbara Moo "C++ Primer", 5th Edition, Addison Wesley, 2012.

19ECOC06 - WEB DESIGNING AND JAVA

SCRIPTING

Web page Designing using HTML, Scripting basics- Client side and server side scripting. Java Script-Object, names, literals, operators and expressions- statements and features- events - windows - documents - frames - data types - built-in functions- Browser object model - Verifying forms - HTML5- CSS3- HTML 5 canvas - Web site creation using tools.   **(5)**

JDBC

JDBC Overview - JDBC implementation - Connection class - Statements - Catching Database Results, handling database Queries. Networking- Inet Address class - URL class- TCP sockets - UDP sockets, Java Beans -RMI.   **(3)**

APPLETS

Java applets- Life cycle of an applet - Adding images to an applet - Adding sound to an applet. Passing parameters to an applet. Event Handling. Introducing AWT: Working with Windows Graphics and Text. Using AWT Controls, Layout Managers and Menus. Servlet - life cycle of a servlet. The Servlet API, Handling HTTP Request and Response, using Cookies, Session Tracking. Introduction to JSP.   **(4)**

WEB BASED APPLICATIONS AND ITS TECHNOLOGIES

Rails: Overview of Rails - Document request - Processing forms - Rails application with databases - Layouts - e-Business Models - e-Marketing - online payments and security.   **(3)**

TOTAL : 15

REFERENCES

1.   Deital&Deital, "Internet and World Wide Web-How to Program", Pearson Education Fifth Edition, 2011.
2.   RashimMogha, Preetham. V.V. "Java Web Services Programming", Wiley Dreamtech, New Delhi, Java 2 Enterprise Edition, 2003. (Server Side Technologies)
3.   Robert W.Sebesta, "Programming with World Wide Web", Pearson Education, Eighth Edition, 2015.

19ECOC07 - VIRTUAL INSTRUMENTATION

INTRODUCTION TO LABVIEW

Introduction to Virtual Instrumentation - Basics of LabVIEW - Loops - Structures - Arrays and Clusters - Graphs and Charts - State Machines - File Input/Output - String Handling. **(4)**

DATA ACQUISITION

Signals Handling and Classification - Signal Conditioning - Analog Interfacing (I/O) - data Acquisition with LabVIEW DAQ Vis - Interfacing with Assistants - Interfacing Instruments. **(3)**

COMMON INSTRUMENT INTERFACES

GPIB-RS232-Handshaking- RS232/RS485 interfacing, VISA - IVI - PCMCIA - SCXI - VXI - Networking basics for office & Industrial applications. **(4)**

APPLICATIONS

Motion Control - Virtual Instrumentation and CAD Tool, Remote Front Panel LabVIEW Applications, Timed Loop Applications Client-Server Applications. **(3)**

TOTAL : 15

REFERENCES

1. *S. Gupta and J. John, "Virtual Instrumentation using LabVIEW", Tata McGraw-Hill Publishing Company Limited New Delhi, 2010.*

2. *Jovitha Jerome, "Virtual Instrumentation Using Labview", Prentice Hall of India, 2010*

3. *Bruce Mihura, "LabVIEW for Data Acquisition", Prentice Hall of India, 2013*

19ECOC08 - INTERNET OF THINGS: A HANDS-ON APPROACH

PREREQUISITES

Basic programming knowledge

Embedded 'C' programs using Arduino uno boards

1. Introduction to Arduino IDE
2. Display LED Brightness on a 16x2 LCD
3. Sensor Interfacing with Arduino (DHT11,PIR,Relay & Motor)
4. Google Assistant Based Voice Controlled Home Automation using DIY Arduino Wi-Fi Shield
5. IoT based weather monitoring system to track temperature and humidity data over the internet using Arduino and ThingSpeak.

Embedded 'C' programs using NODE MCU ESP 8266 boards

1. IoT Controlled LED using Google Firebase Console
2. Track a Vehicle on Google Maps using Arduino, ESP8266 & GPS
3. IoT Based Air Pollution Monitoring System to monitor the Air Quality over a webserver using internet
4. Develop an Android application using MIT App Inventor 2 to control the colour of an RGB LED with a smart phone via Bluetooth module.
5. Develop a simple home security system using Wi-Fi module, HC-SR04 ultrasonic sensor and the IFTTT app

Python Programming using Raspberry Pi boards

1. Getting started with Raspberry Pi - OS Installation, library dependencies, Internet Connectivity.
2. Interfacing XBee Module with Raspberry Pi
3. Data acquisition and control using the MQTT based cloud server with the user interface as Mobile APP and web browser
4. Real Time Face Recognition with Raspberry Pi and OpenCV
5. Optical Character Recognition (OCR) using Tesseract on Raspberry Pi

TOTAL : 15

REFERENCES

1. *"The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press), 2017.*
2. *"Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti, 2014.*
3. *"Arduino Projects and Tutorials" by Rui Santos of the RandomNerd Tutorials.com*

19ECOC09 - MACHINE LEARNING ALGORITHMS USING PYTHON

Module 1   -   Introduction to Machine Learning
Applications of Machine Learning
Supervised vs Unsupervised Learning
Python libraries suitable for Machine Learning

Module 2   -   Regression
Linear Regressions
Non-linear Regression
Model evaluation methods

Module 3   -   Classification
K-Nearest Neighbour
Decision Trees
Logistic Regression
Support Vector Machines
Model Evaluation

Module 4   -   Unsupervised Learning
K-Means Clustering
Hierarchical Clustering
Density-Based Clustering

Module 5   -   Recommender Systems
Content-based recommender systems
Collaborative Filtering

REFERENCES

1. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, 2016.
2. Jason Brownlee, "Machine Learning Algorithms From Scratch with Python", Machine Learning Mastery, 2016.
3. Dipanjan Sarkar, Raghav Bali, Tushar Sharma, "Practical Machine Learning with Python", Apress, 2017.
4. Sebastian Raschka, "Python Machine Learning", Packt Publishing, 2015.
5. Rudolph Russell, "Machine Learning -Step-By-Step Guide to Implement Machine Learning Algorithms with Python", CreateSpace Independent Publishing Platform, 2018.

19ECOC10 - PROGRAMMING IN SCILAB

- Scilab environment
- Scilab workspace and working directory
- Scalars and Vectors
- Matrices
- Polynomials
- Plotting graphs
- Scilab programming language
- Statistics
- Script files and function files

REFERENCES

1. Hema Ramachandran, Achuthsankar S. Nair, "Scilab A Free Software to MATLAB", S. Chand Limited, 2012.
2. Rachna Verma , Arvind Verma, "Introduction to Scilab", 2018
3. Sandeep Nagar, "Introduction to Scilab", Apress, 2017.
4. Vandana Bagla, "Computational Programming Using Scilab", KDP, 2019.
5. Perrine Mathieu, Philippe Roux, "Scilab : I. Fundamentals", Scilab Enterprises, 2016.

19ECOC11 - PCB DESIGN AND FABRICATION

INTRODUCTION& SCHEMATIC CAPTURE

Basics of PCB- History of PCB- Different types of materials : FR-4 , PTFE , Metal - Types of PCB : Single sided , Double sided , Multi-Layer , Rigid , Flex , Rigid-Flex - Packages: Through Hole , Surface Mount , Flat , Small outline , Solder pads , Vias , Solder Mask , Silk Screen , Fabrication Process : Screening , printing , Etching , Drilling , Masking.

Installation process of Altium - Project Creation - Adding sheets - Panels - Compoents-Types of components - Adding components to schematic sheets - Net lanels- Wires - Ports - Connecting components - ERC - Validating schematics - Debugging the errors .   **(7)**

LIBRARY CREATION& PCB LAYOUT

Adding integrated library file - Introduction to Symboyl wizard - Creation of Componentsymboyl - Getting data from data sheet - Introduction to footprint wizard -Measurments- Creating footprint - Validating integrated library.

Adding PCB file - Setting the orgin- Shaping the PCB - Updating schematic components to PCB- Components Placement - Routing : Auto-Routing , Manual Routing- Layer stack , Design Rule Check - Debugging errors - Generating fabrication outputs .   **(8)**

TOTAL : 15

TEXT BOOK

Roger Hu, "PCB Design and Layout Fundamentals" First Edition, 2019

WEB URLs:

Fundamentals of PCB designing - Altium Academy: https://resources.altium.com/

19ECOC12 - DRONE - DESIGN & DEVELOPMENT

INTRODUCTION

Understanding the aerodynamics behind drone - Parts of drone - Construction of drone -Propeller basic - Relation between weight and thrust - Motions in drone- Drone pitch - Rolling motion - Yaw motion - Throttle - Hovering - Factors to be considered while selecting the Motors - Calculation behind parts selection.   **(7)**

EXAMINING, ASSEMBLING AND FLYING

Motors - Electronic speed controller - Propellers- Understanding flight controller - RF transmitter and receiver - Assembling all parts to frame - Calibrating the ESC & flight controller - Possible errors and mistake & rectification - Operating condition -Flying drone.   **(8)**

TOTAL : 15

TEXT BOOK

John Baichtal , "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", 1st Edition,Pearson Education, 2015.

WEB URLs

- *https://www.thecasefarm.co.uk/how-to-build-your-own-drone/*
- *https://travelbydrone.com/important-things-to-know-before-buying-your-first-drone/*
- *https://www.wired.com/story/guide-drones/*
- *https://www.ctia.org/news/up-up-and-away-how-do-drones-work*

19ECOC13 - LoRA TECHNOLOGY

INTRODUCTION TO LoRa AND LoRaWAN:

LoRa specifications-LoRa Modulation techniques-Chirp Spread Spectrum - Spreading Factor -LoRa Spread Spectrum Modulation -LoRaapplications -Network Coverage - Low-Power Wide Area Networks

LoRaWAN specifications- Packet Forwarders -Hardware for End Devices -Hardware for Gateways -LoRaWAN Frequencies - LoRa End Node - MAC Configuration-RFM9x LoRa Radio Transceiver Breakouts -Sensor Integration with Arduino based LoRaWAN Wireless Modules - GPS break out board -LoRa Gateway Configuration. **(7)**

INTEGRATION OF IoT SERVERS WITH A LoRa WIRELESS NETWORKS

Building a low-cost single-channel LoRa gateway based on the Raspberry Pi - Application creation on the Things Network - Connecting with IoT Servers Using a RESTful API -Connecting IoT server using the MQTT protocol with a LoRa wireless network - Upstream/Downstream Data-Local LoRa Server Port- Create /Update Application Server to Data base. **(8)**

Case studies : Design and development GPS tracking system.

TOTAL : 15

TEXT BOOKS

1. *Seneviratne P., Introduction to LoRa and LoRaWAN. In: Beginning LoRa Radio Networks with Arduino. Apress, Berkeley, CA (2019). https://doi.org/10.1007/978-1-4842-4357-2_1*

2. *Daniel Minoli Building the Internet of Things With IPv6 and MIPv6 , The Evolving World of M2M Communications John Wiely ,First Edition. 2013*

3. *David Boswarthick, Omar Elloumi and Olivier_Hersent, M2M Communications, A systematic Approach John Wiely,First Edition. 2012*

WEB URLs:

1. *www.semtech.com/lora/what-is-lora*

2. *www.os.mbed.com/docs/mbed-os/v5.15/tutorials/LoRa-tutorial.html*

19ECOC14 - APPLICATION DESIGN USING RASPBERRY PI & PYTHON

INTRODUCTION TO PYTHON & EMBEDDED SYSTEMS

Basic Python Syntax - Data Types - Numbers and Math functions -Variables & Names -Strings - Conditional statements - For and while Loop - List, Tuple and Dictionary -Python Functions -Modules - Exceptions, File Handling

Embedded Systems - Open source hardware (Raspberry pi) - LED and Switch Interfacing- Digital Sensor Interfacing applications - Actuator Interfacing - Application Development using Digital sensors.   **(7)**

IoT DESIGN USING RASPBERRY PI

Introduction to SPI -Analog Sensor Interfacing applications -Data collection and visualization for real-time systems - Open source IoT cloud and end device -Real time data monitoring application development - Bluetooth Communication using RFCOMM & L2CAP - Sensor Data transmission -Sensor Data transmission through Bluetooth to Cloud -UDP Communication of Devices using WiFi without using Internet - Device Control & application design using UDP - Transmit and Receive Text using UART Communication between two devices - Device Control & Application Design using UART Communication - MQTT based application development - Device Control using Mobile & Web application.   **(8)**

TOTAL : 15

TEXT BOOKS

1. *Gary Mitnick ,"Raspberry Pi 3: Learn to Use Raspberry Pi 3! An Introduction to Using With Python, Scratch, Javascript and More", Createspace Independent Publication, First Edition, 2017*

2. *Tim Cox & Steven Lawrence Fernandes, "Getting Started with Python for the Internet of Things", Packt Publishing; 1st edition ,2019*

3. *Gareth Halfacree&Eben Upton, "Raspberry Pi User Guide" John Wiley & sons, First Edition, 2016.*

19ECOC15 - INTERNET OF THINGS (IoT) COMMUNICATION PROTOCOLS

Introduction to IoT&IoT Communication Protocols

• Introduction to IoT

• Overview of IoT Communication Protocol

• Wireless Development Module

Hardware Implementation on Bluetooth, BLE, Zigbee, Wi-Fi & MQTT protocols

Introduction to Bluetooth & BLE Architecture, Zigbee, Wi-Fi & MQTT protocols

Demo1 : Bluetooth Communication with Wireless Development Module

• Demo2 : BLE Communication with Wireless Development Module

• Demo 3: Zigbee Communication Protocol with Wireless Development Module

• Demo 4: HTTP Protocol with Wireless Development Module

• Demo5: MQTT Communication with Wireless Development Module

Introduction to Long Range Communication Protocol

• Introduction to Long Range Communication Protocols

• LoRa, Sigfox, NB-IoT

• Introduction to 4 Layer & 3 Layer Architecture Model

Three Layer Architecture Model for Long Range Communication

• Hybrid of LoRa with MQTT

• Hybrid of LoRa with TCP

Hardware Implementation on Long Range Communication Protocol

• Demo6: Gateway Registration

• Demo7: Network Server Registration

• Demo8: Application Server Registration

• Demo9: Long Range Communication using Wireless Development Module

TOTAL : 15

REFERENCES

1. *J.-P. Vasseur& A. Dunkels. "Interconnecting Smart Objects with IP: The Next Internet". Morgan Kaufmann, 2010*

2. *Olivier Hersent, David Boswarthick&Omar Elloumi ," The Internet of Things: Key Applications and Protocols, Wiley, First Edition, 2011*

19ECOC16 - COMMUNICATION SKILLS FOR ENGINEERS

Introduction to Communication : Need for effective communication, Functions of Communication and Induction to the students, Communication Cycle, Levels of communication; Flow of communication; Communication networks; General and Technical Communication.

Non-verbal Communication and Body Language : Forms of Non-verbal communication; Kinesics; Proxemics; Chronemics and Effective use of body language.

Presentation Skills : 4Ps (Planning, Preparation, Practice, Presentation), Outlining; Effective use of A/V aids and Modes of Delivery

Listening Skills : Hearing Vs listening, process of listening, types, Barriers to Listening, Qualities of a Good Listener and Active Vs Passive Listening

Speaking Skills : Introducing yourself, Describing a person, place, situation and event, Giving instruction, Making inquiries - at a bank, post-office, air-port, hospital, reservation counter and role play

Writing Skills : Basics of Writing, Paragraph Writing, Precise Writing, Memos, Advertisements, Paraphrasing and Summarizing.

Letter Writing : Informal Letter, (Formal) Business Letters: Essential and Occasional Parts of a letter, layout, Characteristic and Letter of Inquiry, Complaint and Adjustments, orders and replies of it

Report Writing : Format, Structure and Types, Technical Reports, Description and Proposal

Reading Skills : Skimming and Scanning, Intensive and Extensive Reading, Poor habits of reading and The SQ3R Method

Grammar and Vocabulary : Tenses, Determiners, prepositions, conjunctions, Model Auxiliaries, concord, active and passive voice, Homonyms, Homophones, Acronyms.

REFERENCES

1. *Muralikrishna C., Sunita Mishra "Communication Skills for Engineers" 2nd edition, Pearson, New Delhi 2010*
2. *Vyas Manish A., Yogesh L. Patel, "Tasks for the English Classroom", MacMillan, New Delhi, 2012.*
3. *Michael vince, 'Advanced Language Practice', Macmillan Education, Oxford,2003*
4. *Iris, "English for Materials Science and Engineering", Springer Fachmedien Wiesbaden GmbH 2011*
5. *Lougheed Lin, "Business Correspondence: A Guide to Everyday Writing', Longman, Pearson Education, Inc,2003*

19ECOC17 - ENTREPRENEURSHIP AND MANAGEMENT

ENTREPRENEUR : Definition, Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship -Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.

MANAGEMENT : Introduction -Meaning -nature and characteristics of Management, Scope and functional areas of Management -Management as a Science, Art or Profession Management & Administration -Roles of Management, Levels of Management, Development of Management Thought- Early Management Approaches-Modern Management Approaches.

PLANNING : Nature, importance and purpose of planning process -Objectives -Types of plans (Meaning only) -Decision making -Importance of planning -steps in planning & planning premises -Hierarchy of plans.

ORGANISING AND STAFFING : Nature and purpose of organization -Principles of organization Types of organization -Departmentation -Committees - Centralisation Vs Decentralisation of authority and responsibility -Span of control -MBO and MBE Nature and importance of Staffing Process of Selection & Recruitment.

DIRECTING & CONTROLLING : Meaning and nature of directing -Leadership styles, Motivation Theories, Communication - Meaning and importance - Coordination, meaning and importance and Techniques of Co -ordination. Meaning and steps in controlling -Essentials of a sound control system Methods of establishing control.

REFERENCES

1. P. C. Tripathi, P. N. Reddy, "Principles of Management", Tata McGraw Hill, 4th Edition, 2010.

2. Vasant Desai, "Dynamics of Entrepreneurial Development & Management" Himalaya Publishing House, 2010.

3. Donald F.Kuratko, "Entrepreneurship: Theory, Process, Practice", South-Western College Publishing, 2019.

4. Prasanna Chandra, "Projects- Planning, Analysis, Financing, Implementation and review", Tata McGraw Hill, 2012.

5. Manjunath V.S., "Entrepreneurship & Management", Pearson Education, 2010.

19ECOC18 - PROFESSIONAL SKILLS FOR ENGINEERS

Engineer as a Professional, Time Management and Organisational Skills

- Reflective practice for self-development

- Benefits of self-awareness and emotional management

- Personal style and the impact it has in a collaborative environment

- Managing Time: Setting SMART goals and establishing objectives; setting priorities and scheduling time

- Organisational Skills

- Professional Ethics for Engineers

Complex and Creative Problem Solving

- Model Based Problem Solving

- Fault Finding individual issues - SWAT and Taskforce

- Problem Solving Tools - 5 Whys , 5 E + 1 H , Direct Observation Techniques , KT Analysis

- Mental Models

- Critical Thinking with Team Exercise

- Socratic Questioning

Coaching, Mentoring & Team Leadership Skills

- Characteristics of Effective Teams

- Developing Relationships for Effective Teams

- Constructive Feedback, Delivering and Receiving Feedback

- RAPID decision making model

- Key elements of effective meetings

- Key elements of a team charter

Project Management Fundamentals

- The Nature of Projects - background to project management and how it delivers value

- Managing Scope - managing project requirements and developing project work tasks

- Detailed Planning - Preparing Schedules and Budgets

- Project Control - Addressing uncertainty and reporting performance.

Technical Writing Skills

- Structure of reports and proposals; standard practices in presentation of scientific and engineering information

- Standard writing practices, terminology and formatting

- Structure of sentences and paragraphs: clarity, organization, continuity and emphasis

- Organizing and communicating the experimental and technical details

- Standards in the use of graphs and tables for data presentation; schematics, micrographs and pictures

- Quantitative analysis and mathematical descriptions

- Grammatical issues in technical writing

Communication & Presentation Skills

- The Nature of Projects
- Managing Scope
- Detailed Planning
- Project Control

REFERENCES

1. *Kevin Retz, "The Professional Skills Handbook For Engineers And Technical Professionals", CRC Press, 2019.*

2. *Raymond Greenlaw, "Technical Writing, Presentational Skills, and Online Communication", Information Science Reference, 2012.*

3. *Christee Gabour Atwood , "Presentation Skills Training", American Society for Training & Development, 2017.*

4. *Donald J. Treffinger, Scott G. Isaksen, K. Brian Stead-Dorval, "Creative Problem Solving", Prufrock Press,2006.*

5. *David Allred Whetten, "Developing Management Skills", Pearson Education, 2011.*

19ECOC19 - LEADERSHIP AND MANAGEMENT SKILLS FOR ENGINEERS

- Internal and external organisational environments
- Effects of culture on organisations
- Motivation and leadership of project teams
- Diversity and multi-cultural appreciation and management
- Stakeholder management
- Contractual relationships
- Supply chain management
- Nature of professionalism
- Morality, negligence, integrity, responsibility

REFERENCES
1. Dennis W. Hess, "Leadership by Engineers and Scientists", Wiley, 2018.
2. Pamela McCauley, "Essentials of Engineering Leadership and Innovation", CRC Press, 2017.
3. Michael K. Badawy, "Developing Managerial Skills in Engineers and Scientists", Wiley, 1995.

19ECOC20 - INNOVATION MANAGEMENT

EXPLORING INNOVATIONS

•　　Processes used to explore innovations along the technology, market and strategy dimensions as the innovation moves from idea to market.

•　　Introduction to concepts such as Blue Ocean Strategy, Value Network, Disruptive Innovation, Open Innovation　　　**(3)**

EXECUTING INNOVATIONS

•　　Structures and incentives to effectively allow talented individuals from different functions to execute innovation processes

•　　Roles such as Chief Innovation or Technology Officer or Technology Evangelist　　　**(4)**

EXPLOITING INNOVATIONS

•　　Strategies to effectively exploit the value of innovation, including innovation platforms that include multiple products, portfolios, standards and business models　　　**(4)**

RENEWING INNOVATIONS

•　　Processes, structures and strategies for exploring, executing and exploiting innovations that established firms can use to renew their innovation foundations in the face of potentially disruptive innovations　　　**(4)**

TOTAL : 15

REFERENCES

1.　Paul Trott, "Innovation Management and New Product Development", Pearson, Fifth Edition, 2011, ISBN:9781447916079

2.　Joe Tidd and John Bessant, "Managing Innovation: Integrating Technological, Market andorganizational change", Wiley, 2009, ISBN:978-1-118-53859-3.

3.　Burgelman R. Christensen C., Maidique M., Wheelwright S., "Strategic Management ofTechnology and Innovation", McGraw Hill, 2007, ISBN: 9780071232302

19ECOC21 - PROJECT MANAGEMENT

Project management - Concept of a Project - Categories of Project - Project life cycle-Definition of project management - The project as a conversion Process - project environment - complexity of projects - the relationship between project Management and line management - current issues in project management- system approach to project management - Roles and responsibilities of project manager.

Project planning - project planning as a value adding activity - process of project planning - managing the planning process - communicating project plans - Computerized Project Management - planning with standards.

Project implementation - stages - Bottlenecks in project implementation -Guidelines for effective implementation - Management techniques for project management - project monitoring - essentials - roles - tools and techniques - project management environment - management reporting - report designing - project evaluation - project review.

REFERENCES

1. *Project Management - Harvey Maylor - Macmillan India Ltd, 1999.*
2. *Project Management - S. Choudhury - Tata McGraw Hill publishing, 2017.*
3. *Project Management Principles & Techniques - B.B. Goel- Deep & Deep publications Pvt Ltd., 2002.*
4. *Project Planning, Analysis, Selection, implementation and Review - Prasanna Chandra - Tata McGraw Hill Publishing Company Ltd., 2017.*
5. *Project Management A systems Approach to Planning Scheduling and Controlling-Harold Kerzner, CBs Publishers & Distributors, 2003.*

19ECOC22 - HMS FOUNDATION COURSE ON MOBILE APP DEVELOPMENT

Introduction to Android Basics (4)

- First App development, Activities and Life cycle , Permissions
- UI Layout, UI Controls
- Services
- Broadcast receiver, Notification
- Database

Huawei Basic Mobile Services (3)

- Account Kit
- Location Kit
- Map Kit + Site Kit
- HMS Tool Kit - Cloud debugging
- Scan Kit
- Push Kit
- ML Kit
- In-App Messaging

Huawei Advanced Mobile Services (3)

- Ads Kit
- Analytics Kit
- Awareness Kit
- Audio Kit
- Game Service

AppGallery Connect & App Release (5)

- Imake Kit
- Crash SDK
- HMS+GMS Solutions
- HMS Toolkit - Cloud Testing
- A/B Testing
- App Release

TOTAL : 15 HOURS

WEB URLs :

https://developer.huawei.com/consumer/en/training/course/video/101620715873000160

19ECOC23 - BASEBAND COMMUNICATION - SIGNAL GENERATION AND ANALYSIS

Understanding of Baseband Terminology (5 HOURS)

- Understanding of time domain and frequency domain measurement units used in the Industry.
- Understanding Single ended and Differential signaling schemes
- Understanding Analog and Digital signals
- Time period, Frequency, Bandwidth, Symbol rate, Amplitude, Phase, Peak-to-peak, RMS, duty cycle, bits/symbol, Power Spectral density
- Understanding baseband modulation and demodulation

Understanding blocks of Baseband Communication (8 HOURS)

- Understanding of ADC & DAC blocks
- Understanding filters
- Understanding of IF processing
- Understanding Synchronization and equalization
- Understanding Inter symbol Interference
- Understanding Channel - Channel capacity, bandwidth, Channel coding
- Understanding signal processing techniques like mapping & de-mapping, encoding & decoding, Code correction, Pulse Shaping and Windowing

Baseband communication: practical session (7 HOURS)

- Generating and analyzing various baseband signals like Sine, Triangular, Ramp, Pulse
- Generating and analyzing analog modulated signals like AM, FM, PM
- Generating and analyzing digital modulated signals like ASK, FSK, PSK, PWM
- Generating and analyzing higher order IQ modulated signals like QPSK, 8PSK etc.

19ECOC24 - RF MEASUREMENTS LABORATORY

List of Experiments using ME1020 Hardware Kit :   **(15 Hours)**

- Vector network analysis - understanding s-parameter measurements
- Vector network analysis - calibration and shifting of reference planes through port extension
- Vector network analysis of RF Filter - transmission, reflection, impedance on Smith Chart
- Vector network analysis of Amplifier - gain, isolation, gain compression, AM-PM conversion
- Vector network & Spectrum analysis of RF Divider/Combiner - insertion loss, return loss
- Spectrum analysis - understanding Spectrum Analyzer settings
- Spectrum analysis of Frequency Synthesizer and Mixer - harmonics, intermodulation, isolation
- Analyzing Amplifier using Spectrum Analyzer- gain, compression, harmonics and isolation
- Measurement and troubleshooting of RF Transceiver

19CEOE01- TOWN PLANNING AND ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : *interpret the geometric forms and aesthetic qualities of Architecture*

CO2 : *integrate the various elements of architecture and orientation of buildings*

CO3 : *describe the development plans and planning regulations*

CO4 : *incorporate the development control rules in town and country planning*

PRINCIPLES OF TOWN PLANNING

Evaluation of planning - Objects of town planning - principles of town planning- origin of towns - growth of towns - origin - direction - various forms of planning **(9)**

ELEMENTS OF ARCHITECTURE

Introduction of architecture - definition - Evaluation of geometric forms - function and history - Sphere, Cube, Pyramid, Cylinder and Cone - aesthetic qualities of Architecture - Proportion, Scale, Balance, Symmetry, Rhythm and axis - Contrast in Form - Harmony. **(9)**

PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS

Factors affecting orientation - Sun-Wind-Rain - Orientation criteria for Indian conditions - Principles governing the theory of planning - Planning of residential buildings. **(7)**

DEVELOPMENT PLAN

Principles of city planning - levels of planning- scope and contents of regional plan, master plan, detailed development plan and structure plan - preparation and implementation - planning of new towns - slum clearance and urban renewal. **(9)**

PLANNING LEGISLATION AND DEVELOPMENT CONTROL RULES

Planning legislation and administration - Tamil Nadu Town and Country Planning Act, Tamil Nadu Housing Board Act, Tamil Nadu slum clearance and Improvement Act. Zoning regulations - sub division regulations - building regulations - Floor Space Index - minimum plot sizes - open spaces - minimum standard dimensions **(11)**

TOTAL : 45

TEXT BOOKS

1. *RangwalaS.C., "Town Planning", Charotar Publishing House, Anand, 2013.*
2. *Francis D.K., Ching, "Architecture Form, Space and Order", Oxford University Press, 2014.*

ONLINE RESOURCES

1. *https://nptel.ac.in/courses/124/107/124107001/*
2. *https://nptel.ac.in/content/storage2/courses/109104047/pdf/lecture40.pdf*

19CEOE02 - CLIMATE CHANGE AND ADAPTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Outline the earth's system which influences the climatic factors of the earth.

CO2 : Infer the evidences and observed changes in the climate and environment on a global scale and in India.

CO3 : Analyse the impacts of climate change on various sectors and the uncertainties over the projected impacts of climate change.

CO4 : Investigate the various adaptation and mitigation options in various sectors and examine the mitigation efforts made in India.

CO5 : Correlate future clean technology and alternate energy options inferred in clean development mechanism.

EARTH'S CLIMATE SYSTEM

Introduction-Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - The Weserlies - Cloud formation and Monsoon Rains - Storms and Hurricanes - The Hydrological Cycle - Global Ocean Circulation - El Nino and its Effect - Green House Gases and Global Warming - Carbon Cycle.   **(9)**

OBSERVED CLIMATE CHANGE AND ITS CAUSES

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Patterns of Large Scale Variability - Drivers of Climate Change - Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India.   **(9)**

IMPACTS OF CLIMATE CHANGE

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change.   **(9)**

CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones - Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport - Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Mitigation Efforts in India and Adaptation funding.   **(9)**

CLEAN TECHNOLOGY AND ENERGY

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco-friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power.   **(9)**

TOTAL : 45

TEXT BOOKS

1. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*

2. *UNIPCC Fifth Assessment Report, 2014.*

3. *Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.*

REFERENCES

1. *Anil Markandya, Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002.*

2. *Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998.*

3. *Jepma, C.J., and Munasinghe, M., Climate Change Policy - Facts, Issues and Analysis, Cambridge University Press, 1998.*

4. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*

ONLINE RESOURCES

1. *"An Inconvenient truth (2006)"- video*

2. *https://climate.nasa.gov*

3. *https://unfccc.int*

4. *https://environment .gov.au*

19CEOEO3 - METRO SYSTEMS AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : *Integrate the basic elements of MRTS, BRTS, LRTS and other transportation systems*

CO2 : *Illustrate the components of metro rail systems*

CO3 : *Apply the concepts of ITS in the field of Transportation Engineering*

PRINCIPLES OF TRANSPORTATION SYSTEMS

Transportation systems in India - various modes of transport - public transport - Intermediate public transport - types - characteristics - other urban transportation modes - drawbacks- various transit systems **(9)**

MRTS

Definition - Mass Rapid Transit System - History of MRTS - Need for MRTS - connectivity in Indian conditions - cities having MRTS - infrastructure - operations - fares and ticketing - case study. **(8)**

BRTS and LRTS

Bus Rapid Transit System - terminology - history -features - performance - cost - drawbacks - Light Rail Transit System - necessity - types - gauge- capacity integration with cycles - comparison to other rail modes **(9)**

METRO RAIL SYSTEMS

History of Metro trains - Need for Metro rail - connectivity in Indian conditions - cities having Metro - construction techniques adopted in Metro Rail stations - Case study - Delhi Metro (DMRC) - Chennai Metro (CMRL) **(10)**

ITS

Definition - Intelligent Transport System - Principles - Application of ITS technologies in various countries - smart transportation - case studies **(9)**

TOTAL : 45

TEXT BOOKS

1. *Pradip Kumar Sarkar, Vinay Maitri, G. J. Joshi ·"Transportation Planning Principles, Practices and Policies", Prentice Hall India Pvt., Limited 2017*

2. *D. Johnson Victor, S. Ponnuswamy, "Urban Transportation Planning, Operation and Management" Tata McGraw-Hill Education, 2012*

3. *Mashrur A. Chowdhury, Adel Wadid Sadek "Fundamentals of Intelligent Transportation Systems Planning" Artech House · 2003*

4. *Sumit Ghosh, Tony S. Lee, "Intelligent Transportation Systems Smart and Green Infrastructure Design, Second Edition" CRC Press · 2010*

ONLINE RESOURCES

1. *https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf*

19CEOE04 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : *Infer the current energy scenario and future energy usage in India.*

CO2 : *Interpret the concepts of solar energy, wind energy, tidal energy and biomass energy.*

CO3 : *Compare the energy utilization from wind energy, solar energy, biomass energy and tidal energy.*

CO4 : *Correlate the challenges and problems associated with the use of energy sources.*

ENERGY PERSPECTIVES

Conventional and non conventional energies - Energy and sustainable development - Global energy scenario - Energy scenario in India - Energy consumption pattern in rural and urban regions in India - Energy efficiency and economy - Energy losses and its control - Renewable energy potential mapping - Plant load factor **(9)**

SOLAR ENERGY PERSPECTIVES

Concept of solar energy - Solar energy to light and to thermal conversions - Total energy and necessary infrastructure - Units and measurement of solar radiation - Temperature dependent collecting devices and their efficacies - Design aspects - Typical applications: heating, cooling, lighting, power generation and cooking. **(9)**

WIND ENERGY PERSPECTIVES

Wind potential in India - Wind turbines and their types - Merits and demerits - Wind power and appropriate coefficient - Efficiency and performance of wind machines -Energy conversion and storage - Synchronous invertors - Various storage aspects: battery, fly wheel, hydrogen and compressed air. **(9)**

BIOMASS ENERGY PERSPECTIVES

Biomass potential in India - Gobar gas and producer gas - Characteristics of biomass - Operation and design of biogas plants - Objectives, principles and operational aspect of biogassifiers - Pyrolysis and incineration - Power generation from municipal solid waste and industrial Sludges - Application of biodiesel plants - Fuel cells. **(9)**

TIDAL ENERGY PERSPECTIVES

Tidal aspects in coastal India - Tidal energy conversion system: mechanical to electrical and thermal to electrical - Tidal force calculation and power generation - conceptualization and potential of geothermal energy - Geothermal vents. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Sukathme, S.P, Nayak J.K., "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 2017.*

2. *Rai, G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2010.*

3. *P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.*

4. *Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.*

REFERENCES

1. *Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.*

2. *Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.*

3. *Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.*

ONLINE RESOURCES

1. *https://swayam.gov.in/nd1_noc20_ge06/preview*

2. *https://swayam.gov.in/nd2_nou20_cs09/preview*

19CEOE05 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : *Identify the components, factors and environmental issues affecting Sustainable development.*

CO2 : *Assess the role of International summits, conventions and Environmental aspects on Sustainable development.*

CO3 : *Interpret the necessity and importance of Indian and International Socio -economical and legal aspects in Sustainability.*

CO4 : *Illustrate the different strategies to achieve Sustainable development.*

CO5 : *Assess the role of Life cycle Assessment, Cleaner Production and Sustainable Chemistry to achieve sustainable development.*

CONCEPTS OF SUSTAINABLE DEVELOPMENT

Sustainable development- Evolution of Environmental awareness and Sustainable development, global Sustainable development goals -components and factors affecting Sustainable development-Demographic dynamics and sustainability- Environmental issues and crisis- ozone layer depletion, global warming and climate change **(9)**

ENVIRONMENTAL ASPECTS

International Environmental summits, conventions and agreements-Tiwari committee recommendation - Role of Pollution Control Board - Transboundary issues - Ecological indicators- Ecological foot print- Carbon foot print - Basic concept of Environmental impact assessment **(9)**

SOCIO ECONOMIC AND JUDICIAL ASPECTS

UN Sustainable development policies through trade- World Trade Organization-International monetary fund and World bank - Circular Economy and Sustainable Development - Socio economic policies for sustainable Development- Role of Judiciary in Sustainable Development - Major Environmental Cases in India - Development of Environmental Policies in India - Environment Protection Act, 1986 - EIA notification 2006 - National Conservation Strategy and Policy Statement on Environment and Development, 1992 - Policy Statement for the Abatement of Pollution, 1992 - National Environment Policy, 2006. SDG India Index - Baseline Report 2018 **(9)**

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth and Sustainable Development - Resource depletion and resource protection- - Internet of things and Sustainable Development - Sustainable Management of Forest, Land, water- Natural Disaster management- case studies. **(9)**

CLEANER PRODUCTION, LIFE CYCLE ASSESSMENT - GREEN/SUSTAINABLE CHEMISTRY

Cleaner Production, definition, aim, application-Generic process of Cleaner Production Assessment- Life cycle Assessment - definition, necessity and elements- ISO Environmental standards- Environmental Audit -Green Chemistry - twelve Principles of Green Chemistry - case studies. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001*

2. *Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014*

3. *Bimal N. Patel and Ranita Nagar, "Sustainable Development and India", Oxford University Press, 2018.*

REFERENCES

1. Nick Hanley, Jason F. Shogren and Ben White, "Environmental Economics in Theory and Practice", Macmillan Publishers, UK, 1997

2. Tietenberg T. and Lynne Lewis, "Environmental and Natural Resource Economics", Harper Collins, Routledge, 2016

3. Kirkby, J.O., Keefe, P., and Timberlake, "Sustainable Development", Earthsean Pub., London, 2001

ONLINE RESOURCES

1. https://nptel.ac.in/courses/107/103/107103081/

19CEOE06 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : *Identify natural and manmade disasters*

CO2 : *Explain in detail about causes and effects of natural and manmade disasters.*

CO3 : *Apply geospatial techniques (including GIS) that can enhance vulnerability assessments*

CO4 : *Identify and analyse the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans*

CO5 : *Assess and manage these vulnerabilities through disaster planning and policy-making.*

NATURAL DISASTERS

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche. **(9)**

MAN MADE DISASTERS

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire- Oil fire -accident in Mines. **(9)**

GEOSPATIAL TECHNOLOGY

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping. **(9)**

RISK ASSESSMENT AND MITIGATION

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans. **(9)**

DISASTER MANAGEMENT

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism - Role of Engineers in Disaster Management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *R. Subramanian, "Disaster Management" Vikas Publishing House Pvt. Ltd, New Delhi, 2018.*

2. *Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.*

REFERENCES

1. *Disaster Management in India-A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India, 2004.*

2. *Murthy D. B. N., "Disaster Management : Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.*

3. *Sundar I. and Sezhiyan T., "Disaster Management", Sarup and Sons, New Delhi, 2007.*

4. *Singhal J.P. "Disaster Management", Laxmi Publications, 2010.*

5. Khanna BK, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.

6. Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.

7. Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.

19MEOE01 - DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Demonstrate the fundamental concepts applied with mathematical knowledge, methodologies to bring knowledge of characterize, analyse and solve a wide range of problems between the purpose of a model and the appropriate level of complexity and accuracy.*

CO2 : *Plan, design and conduct experimental investigations efficiently and effectively; choose an appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.*

CO3 : *Analyse the nature of variables, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects using RSM.*

INTRODUCTION

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

(7)

BASIC STATISTICAL CONCEPTS

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.

(9)

EXPERIMENTAL DESIGN

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

(11)

ANALYSIS AND INTERPRETATION METHODS

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

(9)

EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

(9)

TOTAL :45

TEXT BOOKS

1. *C.F. Jeff Wu & Michael Hamada, "Experiments-Panning, Analysis, and Optimization", 3rd Edition, John Wiley & Sons. Inc., 2021.*

2. *D.C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley & Sons. Inc. 2019.*

REFERENCES

1. *T.B. Barker, Andrew Milivojevich, "Quality by Experimental Design", 4th Edition, CRC Press, 2021*

2. *https://nptel.ac.in/courses/110/105/110105087/*

3. *https://nptel.ac.in/courses/111/104/111104075/*

19MEOE02 - ENGINEERING OPTIMIZATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Formulate single or multi-variable engineering optimization problems and comply with the appropriate objective functions.*

CO2 : *Select the appropriate optimization technique for the specified engineering problems based on number of variables and constraints.*

CO3 : *Derive, develop and utilize the possible randomness or any other associated factors that would possibly occur during constrained and unconstrained optimization situations.*

INTRODUCTION

Problem formulation - design variables, constraints, constraint surfaces, objective functions, objective function surfaces. Classification of optimization - based on existence of constraints, nature of design variables, structure of the problem, nature of equation involved, permissible value of the design variables, deterministic nature of the variables, separability of the functions and the number of objective functions. Example of engineering optimization problems. **(11)**

SINGLE VARIABLE OPTIMIZATION

Optimal criteria - bracketing method - exhaustive search method, region elimination method - interval halving, Fibonacci, golden search method, point estimation method - successive quadratic approximation, gradient search method - Newton Raphson's method. **(10)**

MULTIVARIABLE OPTIMIZATION WITH CONSTRAINTS

Multivariable optimization - semi definite case - saddle point. Multivariable optimization with equality constraints - solution by direct substitution - solution by the method of constrained variation - solution by the method of Lagrange multipliers. Multivariable optimization with inequality constraints - Kuhn-Tucker conditions, constraint qualification. **(12)**

UNCONSTRAINED OPTIMIZATION

Introduction - classification of unconstrained minimization methods - general approach - rate of convergence - scaling of design variables. Direct Search Methods - random search methods - random walk method with direction exploitation - advantages of random search methods. Indirect Search Methods - gradient of a function - evaluation of the gradient - rate of change of function along a direction - steepest descent (Cauchy) method. **(12)**

TOTAL : 45

TEXT BOOKS

1. S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.

2. K. Deb, "Optimization for Engineering Design - Algorithms and Examples", 2nd Edition, Prentice Hall India, 2013.

REFERENCES

1. J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.

2. Ashok D. Belegundu &Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering", 3rd Edition, Kindle Edition, Cambridge University Press, 2019.

3. *A. Ravindran, K. M. Ragsdell, Reklaitis G.V., "Engineering Optimization: Methods and Applications", John Wiley & Sons, Inc., 2006.*

4. *https://nptel.ac.in/courses/112/105/112105235/*

5. *https://nptel.ac.in/courses/105/108/105108127/*

6. *https://nptel.ac.in/courses/112/101/112101298/*

19MEOE03 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Choose manufacturing processes for polymers and PMC materials to obtain required shapes by applying product design considerations*

CO2 : *Find the processes to develop new ceramic and cermet materials for manufacturing of high temperature cutting tools by applying design considerations*

CO3 : *Develop and characterize the Nano-composites, MMCs, CMCs and PMCs for the engineering applications using secondary processing methods*

CO4 : *Synthesize, characterize, compaction and sintering of metal powders for application of P/M parts using powder metallurgy techniques*

CO5 : *Synthesize and characterize the nanostructured materials for fabricating electronic devices, MEMS, magnetic, electronic and optical sensors and fabricating carbon nano structured materials for fuel cell and energy storage applications*

SHAPING PROCESSES FOR PLASTICS

Properties of polymer melts - extrusion - production of sheet and film - fibre and filament production (spinning) - coating processes - injection moulding - compression and transfer moulding - blow moulding and rotational moulding - thermoforming. Casting - polymer foam processing and forming - product design considerations. **(8)**

RUBBER-PROCESSING TECHNOLOGY

Rubber processing and shaping - manufacture of tyres and other rubber products - product design considerations. **(5)**

SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES

Materials for PMC - open mold processes - closed mold processes - filament winding -pultrusion process - other PMC shaping processes. **(4)**

PROCESSING OF CERAMICS AND CERMETS

Processing of traditional ceramics - processing of new ceramics - processing of cermets - product design considerations. **(4)**

APPLICATION OF COMPOSITES

Composites including Nano-composites for electrical, superconducting and device applications, fabrication of Nano-composites, secondary processing and joining of various composite materials for structural applications and their fracture behavior and safety. **(9)**

POWDERS

Production and characterization of powders, compaction of metal powders - die compaction, isostatic pressing, powder forging, powder rolling and extrusion, pressure less compaction techniques, hot pressing and hot isostatic pressing, sintering of powder compacts, liquid phase sintering, sintering furnaces, post sintering operations, applications of P/M parts. **(7)**

INTRODUCTION TO NANOMATERIALS

Nano structured materials, low-dimensional structures: quantum wells, quantum wires, and quantum dots, Nano clusters & Nanocrystals, electronic and optical properties of Nano crystallites, metallic and semiconducting superlattices, synthesis of nanostructured materials, fabrication and characterization of Nano electronic devices and MEMS, basics of synthesis and

characterization of Nano-multi-component systems for sensors (magnetic, electronic and optical) and electrodes, synthesis and fabrication of carbon Nano structures for fuel cell and energy storage applications. **(8)**

TOTAL : 45

TEXT BOOKS

1. Mikell P. Groover, "Fundamentals of Modern Manufacturing Materials, Processes and Systems", 4th Edition, John Wiley & sons, Inc. 2015.

2. Ajayan P. M., Schadler L. S., & Braun P. V, "Nano composite Science and Technology", John Wiley & Sons, Inc., 2014.

REFERENCES

1. Charles A. Harper, "Modern Plastics Handbook", McGraw-Hill, 2010.

2. Sperling L.H., "Introduction to Physical Polymer Science", 3rd Edition, John Wiley & Sons, 2011.

3. Chawla K.K., "Ceramic matrix composites", 1st Edition, Chapman & Hall, 2013.

4. Randall M German, "A-Z of Powder Metallurgy (Metal Powders Technology)", Elsevier Science, 2007.

5. Upadhyaya G. S., "Powder Metallurgy Technology", Cambridge International Science Publishing, 2002.

19MEOE04 - INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Examine the configuration of a robot and suggest a robot for a particular operation (pick and place, welding, vision, climbing etc.).*

CO2 : *Calculate the position, velocity and acceleration for a robot manipulator and solve the forward and inverse kinematics.*

CO3 : *Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.*

CO4 : *Choose an appropriate vision system for the robot and then extract these images to get the desired output.*

CO5 : *Write a program to determine path for obstacle avoidance for a specific task and can solve using matrix laboratory software.*

INTRODUCTION

Brief history of robots, robot definitions, today's practical importance of robot applications, challenges faced by robots in industrial situations, future scope of robotics. **(3)**

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. **(5)**

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint coordinate system, Euler angles and Euler transformations, Denavit- Hartenburg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse Kinematics, Jacobian of transformation in robotic manipulation. **(12)**

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. **(8)**

MOTION CONTROL OF ROBOTIC MANIPULATORS

General arm control system - open and closed loop control systems error controlled robotic dynamics - control structure of amplifier- control of a single axis robotic arm, common control systems for industrial robots, force control of robotic manipulators. **(9)**

ROBOT SENSING AND ROBOT VISION SYSTEM

Desirable features of sensor- range sensors - proximity sensors - tactile sensors-force sensors, torque sensing detectors - TV cameras - illumination techniques - fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image extraction. Typical vision systems, robot programming languages - characteristics of robot- level languages - characteristics of task level languages, simulation languages. **(8)**

TOTAL : 45

TEXT BOOK

1. *Fu.K S, Gonzales .R.C., & Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*

2. *Ashitava Ghushal "Robotics : Fundamental Concepts and Analysis", Oxford, 2006.*

REFERENCES

1. *Mikell.P.Groover, Mitchell Weiss, Tooger. N. Nager, & Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*

2. *Richard. D. Klafter, Thomas. A. Chmielewski, & Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*

3. *https://nptel.ac.in/courses/112/105/112105249/*

19MEOE05 - BUSINESS PROCESS REENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Gain knowledge about BPR, Factors affecting BPR operations and design BPR techniques.

CO2 : Use BPR tools, utilize concepts of BPR, analyse cost / Benefit and appreciate the need of IT in BPR.

CO3 : Incorporate changes in the business operation based on market demand and implement the same in the manufacturing system.

CO4 : Select an appropriate practice of the business re-engineering project by taking the practical situations into consideration.

CO5 : Provide the most feasible practical solution to the problem keeping in mind the considerations of business automation, value, processes and risks in launching the business reengineering project.

INTRODUCTION TO BPR

Definition; the paradigm shifts in production; the need for BPR, advantages and benefits of BPR, constraining factors, challenges, the positioning concept; the re-engineering visions; The BPR Life Cycle Methodology, Guidelines for BPR steps, Role of Information Technology in BPR; process Improvement and Process Redesign; BPR Experience in Indian Industry.   **(9)**

METHODOLOGIES AND TOOLS FOR BPR

Process management; dynamic business re-engineering change framework; steps to reengineer the process. Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering. Conceptual Foundation of Business Process Re-engineering; Process Identification and Mapping; Role/Activity Diagrams.   **(9)**

CHANGE MANAGEMENT

Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering. Process Visioning and Benchmarking. Business process Improvement, Business Process Redesign; Man Management for BPR implementation; Re-organizing People and Managing Change.   **(9)**

GOVERNANCE & BPR

Total Quality Management, Risk Management, Organizational Structures, BPR Project Management, The Power of Habit in organizations. The role of eLearning environments. Applications, gaming, BPR facilitation, BPR in Software Development, Basic principles, Relation to BPR.   **(9)**

BEST PRACTICES IN BPR

Research & Practice, Perspectives in BPR, Discussion on research challenges, and practice challenges for industry and governments Case studies: Nissan, Chrysler, Hewlett Packard etc. Workflow systems, Imaging technology, Floware, Business design facility tools, Risk and impact measurement.   **(9)**

TOTAL : 45

TEXT BOOKS

1. Davenport, "Process Innovation: Reengineering work through information technology". Harvard Business School Press, 1993.

2. Hammer & Champy, "Reengineering the Corporation: A Manifesto for Business Revolution" Harper Business Books, 1993.

3. *Hammer & Stanton, "The Reengineering Revolution" Harper Collins. London, 1995.*

4. *Henry J Johansson, Patrick McHugh, John Pendlebury & William A. Wheeler, "Business Process Reengineering: Break Point Strategies for Market Dominance", Wiley, New Delhi, 1993.*

REFERENCES

1. *Harmon, P, "Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals", Elsevier/ Morgan Kaufmann Publishers, 2007.*

2. *R. Anupindi et al., "Managing Business Process Flows: Principles of Operations Management", Pearson Education Inc, 2006.*

3. *Kock, N.F., "Process Improvement and Organizational Learning: The Role of Collaboration Technologies", Idea Group, 1999.*

5. *Walford, R.B., "Business Process Implementation for IT Professionals and Managers" Artech Business Process Reengineering" Prentice Hall, New Delhi, 1993.*

19MEOE06 - ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : *Analyze the demand and supply and sketch a demand and supply curve.*

CO2 : *Determine the Breakeven point and find out the strength and weakness of the Market Structure.*

CO3 : *Sketch the curve for cost behavior for the short run concept.*

CO4 : *Analyze and specify the causes and provide the solution to each cause.*

CO5 : *Formulate the steps involved in a recruitment process as a chart and interpret it.*

INTRODUCTION

Definition -Nature and Scope-Significance of Economics for Engineers. **(5)**

BASICS OF MICRO ECONOMICS

Demand Analysis and Supply Analysis - Elasticity of Demand and Supply - Case Study in Demand Forecasting - Cost concepts - Classifications - Short run and Long run cost curves - Break-even Analysis. **(8)**

MARKET STRUCTURE

Classification of Market - Perfect Competition-Characteristics -Monopoly - Monopolistic Competition - Oligopoly and Duopoly - Price Discrimination under different markets - Price and output determination in short run and long run. **(8)**

MONEY AND BANKING

Money - Quantity theory of Money -Supply of Money - RBI Measures of Money Supply - Banking - Functions of Commercial Banks and Central Banks- Balance of Payments - Meaning and methods of Exchange control Methods of Foreign Payments - IMF, IBRD, WTO- Agreements of WTO and its Impact on Indian Economy. **(9)**

NATIONAL INCOME

Meaning - National Income - Concepts -Methods of Calculating and Problems in calculating National Income - Inflation - Causes - Measures -Deflation - Stagflation - Phillips Curve - Unemployment New Environment Policy- Liberalisation -Privatisation - Globalisation. **(8)**

HUMAN RESOURCE MANAGEMENT

Principles of Management, Evolution of Management, Development of Managerial Skills- Human Resource Management-Importance- Objectives- Job Analysis- Recruitment- Selection and Placement and Training Development. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Dewett. K. K., & Navalur M.H., "Modern Economic Theory", S. Chand and Company Ltd, New Delhi, 2014*

2. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010*

3. *V. S. Bagad, "Principles of Management", Technical Publication, Pune*

REFERENCES

1.   Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.

2.   Francis Cheriunullem, "International Economics", McGraw Hill Education, 2011.

3.   William A McEachern & Smrit Kaur, "Micro Economics", Cengage Learning, 2013.

4.   William A McEachern & Indira A., "Macro Economics", Cengage Learning, 2014.

5.   Lipsey & Chrystal, "Economics", Oxford University Press, 2010.

6.   https://nptel.ac.in/courses/112/107/112107209/

19EEOE01 - ENERGY AUDITING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Exhibit Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing*

CO2 : *Compute the thermal efficiency of various thermal utilities and use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.*

CO3 : *Analyse the cost- benefit of various investment alternatives for meeting the energy needs of productive processes through energy conservation study.*

CO4 : *Illustrate the energy saving techniques to reduce power consumption of the non- productive loads*

CO5 : *Advocacy of strategic and policy recommendations on energy conservation and energy auditing.*

ENERGY AUDIT

Global energy scenario - Heat and Electrical energy - Role of energy managers in industries - Energy auditing -Types of energy audit- Data to be collected in auditing - Needs, methodology and types of energy audits - Simple payback period - Net present value of saving- Energy audit report **(9)**

ELECTRICAL ENERGY CONSERVATION

Basic Industrial electrical distribution- energy saving and energy efficiency with Transformers, reactive power correction and cable loss reduction- Energy saving in lighting systems -Specific Energy Consumption (SEC) - Load management - Demand Side Management (DSM). **(9)**

HEAT ENERGY CONSERVATION

Energy Audit - Losses in Boiler - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications- Cogeneration- Heating, ventilation and air conditioning systems (HVAC) :Types - energy conservation in cooling towers and Spray ponds. **(9)**

BUILDING, TRANSPORT AND UTILITY ENERGY CONSERVATION

Real buildings systems: Consumption - Cost versus lifecycle cost - Building design - Water supply systems Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Energy conservation inpumps, and fan and blowers - Energy efficient motors. **(9)**

ENERGY AUDIT PLANNING AND MONITORING

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM). **(9)**

TOTAL : 45

TEXT BOOKS

1. *D. P. Sen Gupta, K. R. Padiyar, IndranilSen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.*

2. AmlanChakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2012.

3. YP.Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.

4. Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2007.

5. C.B. Smith, "Energy Management Principles", Pergamon Press, New York, 1981.

REFERENCES

1. "General Aspects of Energy Management and Energy Audit-Unit- 1,2,3,4", BEE Guide book, 2010.

2. Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & case study", Hemisphere, Washington, 1980.

3. Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.

4. Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall, May 1984

5. Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988.

19EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Summarize the solar radiation, measurements and characteristics of solar PV cell.*

CO2 : *Develop the model of a PV system and its applications.*

CO3 : *Illustrate the basic types, mechanical characteristics and model of wind turbine.*

CO4 : *Analyse the electrical characteristics and operation of various wind-driven electrical generators.*

CO5 : *Utilize various power electronic converters used for hybrid system.*

SOLAR RADIATION AND SOLAR CELL FUNDAMENTALS

Basic characteristics of sunlight - solar spectrum - insolation specifics- irradiance and irradiation pyranometer - solar energy statistics- Solar PV cell - I-V characteristics -P-V characteristics- fill factor. Modeling of solar cell- maximum power point tracking. **(9)**

SPV SYSTEM PERFORMANCE AND APPLICATIONS

PV module - blocking diode and by -pass diodes- composite characteristics of PV module - PV array - solar cell array design concepts - Peak power operation-System components. PV- powered fan-PV fan with battery backup - PV-powered pumping system - PV powered lighting systems - grid - connected PV systems. **(9)**

WIND ENERGY FUNDAMENTALS AND COMPONENTS

Wind source-wind statistics-energy in the wind- Basic principle of wind energy conversion - nature of wind - power in the wind -turbine power characteristics- parts of wind turbines- braking systems-tower-Maximum power operation. **(9)**

WIND TURBINE TYPES AND CONTROL

Classification of WECS - Generating Systems - DC generator, Synchronous generator, Induction -generator, Doubly fed Induction generator, Direct -driven generator- generator control - load control. **(9)**

SYSETM INTEGRATION

Energy storage-Power electronic converters for interfacing wind electric generators - power quality issues- Hybrid system: wind - diesel systems, wind-solar systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. *S N Bhadra, S Banerjee and D Kastha, "Wind Electrical Systems", Oxford University Press, 1st Edition, 2005.*

2. *Chetan Singh Solanki, "Solar Photovoltaic's: Fundamentals,Technologies and Applications" PHI Learning Publications, 3rd Edition, 2015.*

REFERENCES

1. *Roger A. Messenger and Jerry Ventre, "Photovoltaic systems engineering", Taylor and Francis Group Publications, 2020.*

2.   M.Godoy Simoes and Felix A. Farret, "Alternative Energy Systems: Design and Analysis with Induction Generators", CRC press, 2nd Edition, 2008.

3.   Ion Boldea, "The electric generators hand book - Variable speed generators", CRC press, 2015.

19EEOE03 - ELECTRICAL SAFETY PROCEDURES AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Identify and analyze the precautions and protection of electrical hazards*

CO2 : *Select and use the suitable personal protective equipment according to the working environment*

CO3 : *Interpret the safety procedures for the specific work place*

CO4 : *Analyze and apply the various grounding techniques*

CO5 : *Infer the electrical safety against low voltage and high voltage and to manage the medical equipments*

INTRODUCTION AND HAZARDS OF ELECTRICITY

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only) **(9)**

ELECTRICAL SAFETY EQUIPMENT

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/ Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials. **(9)**

SAFETY PROCEDURES

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit. **(9)**

GROUNDING AND ELECTRICAL MAINTENANCE

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing - Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard. **(9)**

VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure- Stationary battery safety - Accident prevention - Accident investigation - First aid - Rescue techniques - Electrical safety program structure and development - Safety meetings - Safety audits. **(9)**

TOTAL : 45

TEXT BOOK

1. *John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th Edition, Mc Grew Hill, 2012*

REFERENCE S

1   Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013

2.   Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014

3.   Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection association, Quincy, 2011

4.   Electrical Safety booklets issued by Government bodies

19EEOE04 - ENERGY EFFICIENT ILLUMINATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.*

CO2 : *Perform the calculation of luminance parameters in various applications.*

CO3 : *Identify the criteria for selection of lighting equipment's and control systems in various applications.*

CO4 : *Impart design and technology for Interior lighting and Exterior lighting applications*

CO5 : *Review the various technologies used in Smart lighting systems.*

INTRODUCTION : BASICS OF LIGHTING

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting. **(7)**

LIGHTING CALCULATIONS AND LIGHT SOURCES

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software.

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps - Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy. **(12)**

LIGHTING EQUIPMENTS AND STANDARDS

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system. **(9)**

LIGHTING APPLICATIONS

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles. **(8)**

SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.*

2. *Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008*

3. *Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press, Washington DC, 1st Edition, 2010.*

4. *Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.*

REFERENCES

1. *Lighting Engineering: Practical Hand Book, INDALUX 2002*

2. *IES Lighting Handbook, 10th Edition, 2011.*

3. *NPTEL Course: Illumination Engineering*

4. *Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.*

19EEOE05 - ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Apprehend the fundamentals and importance of electric vehicles and its components*

CO2 : *Select the suitable drive scheme based on the motor and topology for the given specification and applications*

CO3 : *Design and categorize the battery system for electric vehicles and hybrid electric vehicles*

CO4 : *Recognize the suitable battery charging scheme for different environments and applications.*

CO5 : *Describe the significance of E-mobility and its various business opportunities*

ELECTRIC VEHICLES

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance - Gradability **(9)**

ELECTRIC PROPULSION

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives - Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- 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 **(9)**

BATTERIES

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices **(9)**

BATTERY CHARGING

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolatedcharger topology - Transformer less topologies. **(9)**

E-MOBILITY

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **(9)**

TOTAL : 45

TEXT BOOKS

1. *Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition CRC Press, 2018.*

2. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021*

REFERENCES

1. *James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012*

2. *Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.*

3. *J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd Edition, London, UK, 2010.*

4. *R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.*

5. *Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.*

19EEOE06 - ENERGY EFFICIENCY IN THERMAL AND ELECTRICAL UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Preaudit the energy*

CO2 : *Analyse the possibility of energy savings*

CO3 : *Analyze the methods of energy savings*

CO4 : *Design the solutions*

CO5 : *Identify and perform appropriate energy management*

ENERGY EFFICIENCY IN THERMAL UTILITIES - I

- Fuels and Combustion: Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal, and gas.

- Boilers: Types, combustion in boilers, performance evaluation, analysis of losses, feedwater treatment, blowdown, energy conservation opportunities..

- Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

- Insulation and Refractories: Insulation-types and application, the economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss.

- FBC boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, Retrofitting FBC system to conventional boilers, saving potential.   **(9)**

ENERGY EFFICIENCY IN THERMAL UTILITIES - II

- Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate, and flash steam recovery system, identifying opportunities for energy savings

- Cogeneration: Definition, need, application, advantages, classification and saving potentials.

- Waste Heat Recovery: Classification, advantages, and applications, commercially viable waste heat recovery devices, saving potential.

- Energy Management & Audit: Definition, need and types of an energy audit. Energy management (audit) approach- understanding energy costs, benchmarking, energy performance, matching energy use to the requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

- Material and Energy balance: Facility as an energy system, methods for preparing process flow, material, and energy balance diagrams.   **(9)**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

- Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.

- Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and

motor replacement issues, energy-saving opportunities with energy- efficient motors.

- Energy-Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy-efficient motors, soft starters with energy savers, variable speed drives, energy-efficient transformers, electronic ballasts, occupancy sensors, energy-efficient lighting controls. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - I

- Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities

- HVAC and Refrigeration System: Vapor compression refrigeration cycle, refrigerants, the coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.

- Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system, saving potentially

- Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

- Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - II

- Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy-saving opportunities assessment of cooling towers.

- Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.

- Diesel Generating system: Factors affecting the selection, energy performance assessment of diesel conservation avenues **(9)**

TOTAL : 45

ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT AND UTILITY SYSTEMS

Open Book examination on the following energy performance assessments for equipment and utility systems:

- Boilers, Furnaces
- Cogeneration, Turbines (gas, steam)
- Heat Exchangers
- Electric Motors, Variable Speed Drives
- Fans and Blowers, Water Pumps, Compressors
- HVAC systems
- Lighting Systems
- Performing Financial Analysis.
- Applications of Non-conventional & Renewable Energy Sources (NRES)
- Waste minimization and resource conservation

TEXT BOOKS

1. *Mehmet Kanolu, Yunus A. Çengel, "Energy efficiency and management for engineers", McGraw- Hill Education, 2020*
2. *Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Handbook", 9th Edition, River Publishers, Taylore and Francis Group, 2020*

3. *Energy Efficiency in Thermal Utilities, Bureau of Energy Efficiency (BEE), Guide books*

4. *Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency (BEE), Guide books*

REFERENCES

1. *Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2017*

2. *Wayne C. Turner," Energy Management Handbook", Eighth Edition, 2012*

3. *Stephen A. Roosa, Steve Doty, "Energy Management Handbook", 2018*

4. *General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency (BEE), Guide books*

5. *Energy Performance Assistance for Equipment and Utility Systems, Bureau of Energy Efficiency (BEE), Guide books*

19ECEOE01 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Compute the Discrete Fourier Transform (DFT) of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms and design FIR/IIR Filters*

CO2 : *Apply source coding procedure to calculate coding efficiency based on entropy & mutual information and outline different pulse analog modulation techniques*

CO3 : *Analyze various equalization techniques and compare its performance*

CO4 : *Calculate channel capacity using Shannon's channel capacity theorem and develop channel error control codes*

CO5 : *Analyze speech processing methods in time and frequency domain and design codec methods for speech compression techniques*

ORTHOGONAL TRANSFORMS AND DIGITAL FILTER STRUCTURES

DFT-DCT-Properties of DFT- Computation of DFT, FFT and structures-Decimation in time-Decimation in frequency - Linear convolution using DFT

Basic FIR/IIR filter structures-FIR/IIR Cascaded lattice structures-Parallel allpass realization of IIR transfer functions- Sine cosine generator - Computational complexity of filter structures **(10)**

DATA COMPRESSION

Information entropy-Source coding-Huffman algorithm-Delta Modulation-Adaptive Delta Modulation- Continuously Variable Slope Delta Modulation-Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation. **(8)**

SIGNAL PROCESSING IN COMMUNICATION RECEIVER

Temporal Equalization-Space Time Equalization-Frequency Domain Equalization-Symbol Timing Recovery- Channel Quality Estimation- Automatic Frequency Control-Overall Receiver Block. **(9)**

ERROR CORRECTING CODES & CHANNEL CODING

Error Correcting codes-Error Correction-Linear Blocks Codes-Cyclic Codes- Bose, Chaudhari and Hocquenghem Codes-Convolution Codes-Viterbi Decoding-Interleaving Codes-Concatenated Codes- Turbo Codes. **(9)**

SPEECH CODING

Speech Coding-Adaptive Predictive Coding-Sub Band Coding,-Vocoders-Liner Predictive Coding- Image Coding-Joint Photo Graphic Expert Group (JPEG)-Moving Pictures Expert Group (MPEG), the layer-3 of MPEG-1 Algorithms(MP3),Lempel- ZIV Algorithms - Recognition techniques:Speech Recognition and Image recognition. **(9)**

TOTAL : 45

TEXT BOOKS

1. V. Oppenheim, R. W. Shafer and J.R.Buck, "Discrete-Time Signal Processing", Pearson Education, 3rd Edition, 2011.

2. Simon Haykin, "Digital Communications Systems", 1st Edition, Wiley, 2013.

REFERENCES

1. *Sanjit. K. Mitra and Sanjit Kumar Mitra, "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.*

2. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 2005.*

3. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003*

4. *L.R.Rabiner and R.W.Schaffer "Digital Processing of Speech signals" Prentice Hall 1978*

5. *Nirmal K. Bose, Calyampudi Radhakrishna Rao, "Signal Processing and Its Applications" North-Holland, 1993*

19ECEOE02 - SMART SENSORS AND IoT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the classification ,types,packaging and testing of smart sensors*

CO2 : *Interpret the construction and working principles of Electronic sensors*

CO3 : *Exemplify the working of different types of light radiation sensors .*

CO4 : *Illustrate the key concepts of temperature ,gas and airquality sensors used to measure the parameters.*

CO5 : *Interpret the characteristics, functional blocks and architecture of IoT to develop an IoT based applications.*

SMART SENSORS BASICS

Sensor Classification, Performance and Types, Error Analysis characteristics- Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications-Testing Smart Sensors- HVAC Sensor Chip- Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control-MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. **(9)**

ELECTRONIC SENSORS

Resistance strain gauge - piezoelectric pressure gauge - characteristics- load cells-torque sensor- Piezo-resistive and capacitive pressure sensor- optoelectronic pressure sensors- vacuum sensors- Capacitor plate sensor, Inductive sensors, LVDT- Hall effect- Doppler detectors- liquid level detectors, flow sensors - ultrasonic sensor- flow sensors. **(9)**

GHT RADIATION SENSORS

Electronic and Optical properties of semiconductor as sensors - LED - Semiconductor lasers- Fiber optic sensors- Thermal detectors - Photo multipliers- photoconductive detectors- Photo diodes- Avalanche photodiodes - CCDs - Intensity sensor - Interferometers-Phase sensor: Phase detection, Polarization maintaining fibers. **(9)**

TEMPERATURE, GAS AND AIR QUALITY SENSORS

Bimetallic strip- Bourdon temperature gauge- thermocouples- Resistance thermometers- thermistors- bolometer- Pyroelectric detector-Engine combustion process- Catalytic exhaust after treatment, Emission limits- Exhaust sensors and Engine control - Exhaust sensors for OBD- Hydro-Carbon Sensors- NOx-Sensors-Oxygen Sensors- Measurement of oxides of sulphur,oxides of nitrogen unburnt hydrocarbons, carbonmonoxide, dust mist and fog- smoke sensors. **(9)**

IoT AND ITS APPLICATIONS

IoT Definition - Characteristics - IoT Functional Blocks -IoT Architecture -Physical design of IoT - Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Jacob Fraden," Handbook of modern sensors: physics, designs, and applications", 5th Edition, Springer, 2016.*

2. *Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, Boston, 2011.*

REFERENCES

1. *Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.*

2. *Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier, 1st Edition, Netherland, 2011.*

3. *John G Webster, "Measurement, Instrumentation and sensor Handbook", CRC Press, 2nd Edition, Florida, 2017.*

4. *John P. Bentley," Principles of Measurement systems", 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.*

5. *D. Patranabis," Sensors and Transducers", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.*

6. *Ernest O Doebelin, Dhanesh N Manik, "Measurement Systems, Application and Design", McGraw Hill, 6th Edition, 2007.*

19ECEOE03 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand the various types of microphones and loudspeaker.*

CO2 : *Explain the principle and working of Monochrome TV.*

CO3 : *Describe the Colour TV scanning process and camera tube.*

CO4 : *Illustrate LCD, LED TV, working of cable TV and DTH.*

CO5 : *Interpret the significant technical considerations using a broad systems perspective.*

AUDIO SYSTEMS

Microphones Carbon, moving coil, wireless microphone; Loudspeakers - Direct radiating Electrostatic and horn loudspeaker; Multi-speaker system; Sound Recording - Magnetic Recording, Digital Recording, Optical Recording (CD system and DVD). **(9)**

MONOCHROME TV

Elements of TV communication system, Scanning process, Scanning methods and Aspect Ratio, Need of synchronizing and blanking pulses, Composite Video Signal, Camera Tube: Vidicon. **(9)**

COLOUR TELEVISION

Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, Concept of Compatibility with Monochrome Receiver, NTSC, PAL, SECAM. **(9)**

LCD AND LED TELEVISION

Basic principle and working of LCD & LED TV, Cable Television: Working of Cable TV, DTH **(9)**

DOMESTIC & CONSUMER APPLIANCES

Operation of Microwave Oven, Automatic Washing Machine, Photostat Machine, Digital Camera, Vacuum cleaner, Food Processors, Scanner. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bali S.P., "Consumer Electronics" Pearson Education, 2017.*

2. *Bali R and Bali S.P. "Audio video systems: principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd., 2010.*

REFERENCES

1. *Gulati R.R., "Modern Television practices" New Age International Publication (P) Ltd.2011.*

2. *Gupta R.G, "Audio video systems" Tata Mc graw Hill, 2nd Edition, 2010.*

3. *Whitaker Jerry & Benson Blair, "Standard Handbook of Audio engineering" McGraw-Hill Professional, 3rd Edition, 2010.*

4. *Amit Dhir, "The Digital Consumer Technology Handbook", Elsevier Science, 2004.*

19ECEOE04 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

Upon completion of this course, students will be able to demonstrate an ability to

CO1 : *Describe the concepts of robotics, safety measures and homogeneous transformation.*

CO2 : *Formulate the concepts of mechanical drives and sensors in robotics.*

CO3 : *Describe the types of sensors and Robotic Vision*

CO4 : *Develop robotics programming, classifications and its applications.*

CO5 : *Exemplify the concepts of artificial intelligence.*

ROBOT KINEMATICS

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics. **(10)**

ROBOTIC DRIVERS AND CONTROLS

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism. **(9)**

SENSORS AND MACHINE VISION

Need for sensing systems- Principles and Applications of the following types of sensors- Position and displacement sensors - Potentiometers, Encoders, Linear Variable Differential Transformer, Force and Torque sensors- Wrist sensor, Joint sensor, Tactile array sensor, Slip sensors- Proximity sensors- Range finders- Imaging sensors- Inductive Proximity switch- Acoustic sensors- Opto-electronic sensors- Lighting Techniques, Robot Vision- Sensing and Digitizing, Image Processing and analysis- Preprocessing, Segmentation, Description, Recognition, Interpretation and Applications of robot vision system **(9)**

ROBOTIC LANGUAGE AND PROGRAMMING

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language. Applications of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance. **(8)**

ARTIFICIAL INTELLIGENCE IN ROBOTICS

The history of Artificial Intelligence- Artificial and Natural Intelligence- Artificial Intelligence and Automated manufacturing- The application domains of Artificial Algorithms- Risks and Benefits of AI- Agents and Environments- Knowledge representation.

(9)

TOTAL : 45

TEXT BOOKS

1. *Satya Ranjan Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, 2nd Edition, 2012.*

2. *Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.*

REFERENCES

1. *Robin.R.Murphy, "Introduction to AI Robotics", The MIT Press, Canbridge, Massachusetts, London, England, Second Edition, 2019.*

2. *Jadran Lenarcic, Jean-Pierre Merlet, "Advances in Robot Kinematics 2016", Springer International Publishing AG, 2018.*

3.   Peter McKinnon, "Robotics", CreateSpace Independent Publishing Platform, 2016.

4.   Ritu Tiwari, Anupam Shukla, Rahul Kala, "Intelligent Planning for Mobile Robotics: Algorithmic Approaches", Information science reference, United states of America, 2013.

5.   David. L. Pool and Alan. K. Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University, 2011.

19ECEOE05 - INFORMATION THEORY AND CODING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Explain the information content in a discrete memoryless source through parameters such as entropy and mutual information.*

CO2 : *Estimate a channel's capacity based on Shannon's channel capacity theorem*

CO3 : *Analyze various channel encoding and decoding methods*

CO4 : *Design and develop an error control coding methods for random error and burst error detection and correction techniques*

CO5 : *Understand different applications in coding techniques*

INFORMATION THEORY AND SCHEMES FOR SOURCE CODING

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel

SOURCE CODING : Prefix codes - Necessary conditions for source coding - Kraft Mcmillan Inequality- Huffman Coding- Shannon Fano Coding Efficiency calculations.   **(9)**

MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING

Discrete Memoryless Channel - Channel models - BSC and BEC channels - Cascaded channels - Channel capacity of discrete and analog channels - Channel capacity of a Gaussian channel-Bandwidth-S/N trade-off-Channel coding theorem - Information capacity theorem - Code rate and redundancy-Parity check codes - Rate Distortion Theory.   **(9)**

LINEAR BLOCK CODES AND CYCLIC CODES

Rationale for coding - Types of codes - Matrix description of linear block codes - Syndrome decoding - Minimum distance considerations -Repetition codes - Dual codes- Cyclic codes :Generator polynomial - Parity check polynomial - Encoder of cyclic codes - Calculation of syndrome - Cyclic codes for error correction.   **(10)**

CONVOLUTIONAL CODES

Convolutional codes : Tree codes- Trellis codes- Viterbi decoding of convolutional codes - Catastrophic Error Propagation in Convolutional Codes -Performance Bounds for Convolutional Codes - Coding Gain - Convolutional Code Trade off - Soft Decision Viterbi Decoding -Feedback Decoding - Sequential Decoding   **(9)**

CODING TECHNIQUES IN DATA COMPRESSION

Static and Dynamic Huffman coding - Arithmetic coding - Run length encoding- Lempel-Ziv coding -Image compression techniques -JPEG standard for Lossy and Lossless compression- Video compression standards.   **(8)**

                                                  TOTAL : 45

TEXT BOOKS

1.   *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.*

2.   *Ranjan Bose, "Information Theory Coding and Cryptography", Tata McGraw Hill, 3rd Edition 2016.*

REFERENCES

1. *Richard B.Wells, "Applied Coding and Information Theory for Engineers", Pearson Education, 1st Edition Indian reprint, 2009.*

2. *Khalid Sayood, "Introduction to Data Compression", 4th Edition, Elsevier, 2012.*

3. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*

4. *Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons, 2nd Edition, 2006.*

5. *Reza F M, "An Introduction to Information theory", McGraw Hill, 2000.*

6. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 1st Edition, 2021.*

19ECEOE06 - WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Outline the challenges & issues in the wireless sensor network and its subsystems and interpret network architecture and its components*

CO2 : *Describe the essential principles of the MAC protocols for Wireless Sensor Networks*

CO3 : *Elucidate the Routing & localization tracking inWireless Sensor Networks*

CO4 : *Discuss the features of WSN Operating systems*

CO5 : *Illustrate the methodologies to provide WSN based solution for various critical issues.*

SENSOR NETWORKS - INTRODUCTION & ARCHITECTURES

Challenges for Wireless Sensor Networks-Enabling Technologies for Wireless Sensor Networks- Characteristic requirements for WSN - WSN architecture - Commercially available sensor nodes -Imote, IRIS, Sunspot -Physical layer and transceiver design considerations in WSNs-Single Node Architecture -Energy Consumption of Sensor Nodes- Sensor Network Scenarios- Optimization Goals and Figures of Merit. **(9)**

DATA LINK LAYER

Fundamentals of MAC protocols- Issues in designing a MAC Protocol for WSN - Low duty cycle protocols and wakeup concepts - Contention based protocols:PAMAS - Schedule-based protocols:LEACH - Sensor MAC - Berkeley MAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4- Link Layer protocols - fundamentals task and requirements, error control, framing, link management, Address and Name Management, Assignment of MAC Addresses, Unique,Content-based and geographical addressing. **(10)**

ROUTING AND TRACKING

Routing Challenges and Design Issues in Wireless Sensor Networks- Taxonomy :Data-centric routing SPIN - Energy aware routing, Gradient-based routing -Hierarchical Routing LEACH -Location Based Routing GAF, Data aggregation - Various aggregation techniques

A Tracking Scenario - Problem formulation - Distributed representation and inference of states- Tracking multiple objects - Sensor models - Topology control - Clustering - Time synchronization - Localization and Localization Services **(10)**

EMBEDDED OPERATING SYSTEMS FOR WSNs

Embedded Operating Systems: Operating Systems for WSNs - Introduction - Operating System Design Issues- Introduction to Tiny OS - NesC - Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM. **(7)**

APPLICATIONS OF WSN

WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications - Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling **(9)**

TOTAL : 45

TEXT BOOKS

1. *Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, First Edition, 2007.*

2. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.*

REFERENCES

1. *Anna Hac, "Wireless Sensor Network Design", John Wiley & Sons, First Edition, 2003.*

2. *C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer Publication, 2004.*

3. *Paolo Santi, "Topology Control in Wireless Adhoc and Sensor Networks", John Wiley & Sons, 2005.*

4. *Philip Levis, David Gay,"TinyOS Programming", Cambridge University Press, 2009 Contiki - Open Source Operating System for IoT - http://www.contiki-os.org/*

19ECEOE07 - AUTOMOTIVE EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Design modules for hybrid vehicle using automotive system components.*

CO2 : *Design control system in automotives by appropriate choice of Microcontrollers, Sensors and actuators.*

CO3 : *Examine the communication protocols for real time applications*

CO4 : *Understand the safety and comfort in Automobiles as per the government test procedures.*

CO5 : *Understand the communication and diagnostic protocols*

AUTOMOTIVE SYSTEMS

Overview of Automotive industry - Tools and Processes - Introduction to modern automotive systems -Spark and Compression Ignition Engines - Automotive Transmissions - Vehicle braking fundamentals -Steering Control - Overview of Hybrid Vehicles - Analog and Digital Systems - Basic measurements systems. **(9)**

SENSORS AND ACTUATORS

Sensors: Characteristics, response and modeling - Actuators - Microcontroller and Digital Signal Processors used for automotive applications. **(9)**

EMBEDDED COMMUNICATION

Embedded Automotive Protocols: CAN, LIN, FLEXRAY, MOST **(9)**

SAFETY SYSTEMS

Active Safety Systems: ABS, TCS, ESP, brake assist - Passive Safety Systems: Airbag systems, Advance Driver Assistance system (ADAS) -Computer vision techniques - Connected cars technology - Trends towards Autonomous vehicles. **(9)**

FUNDAMENTALS OF DIAGNOSTICS

Basic wiring system and Multiplex wiring system, Self-Diagnostic system - various On board and off board diagnostics in Automobiles - Diagnostics tools - Diagnostics Protocols: KWP20000 and UDS. **(9)**

TOTAL : 45

TEXT BOOK

Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2ⁿᵈ Edition 1999.

REFERENCES

1. *William B. Ribbens, Ph.D, "Understanding Automotive Electronics", Elsevier Publications, 7ᵗʰ Edition, 2012.*

2. *Tom Denton, "Advance Automotive Diagnosis", 2ⁿᵈ Edition, Elsevier 2006.*

3. *BOSCH Automotive Handbook, 8ᵗʰ Edition.*

4. *Denton. T, "Automobile Electrical and Electronics Systems", SAE (Society for Automobile Engineers) International, 3ʳᵈ Edition, 2004.*

5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5ᵗʰ Edition, 2009.*

19ECEOE08 - 5G TECHNOLOGIES AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *describe the evolution of cellular systems from 2G to 4G*

CO2 : *explain the motivation, targets of 5G technology and its standardization*

CO3 : *elaborate the 3GPP releases and 5G radio access network architecture*

CO4 : *discuss the services offered by 5G deployment and its design approaches*

CO5 : *understand the role between 5G and emerging next generation wireless technologies*

EVOLUTION OF CELLULAR SYSTEMS

Evolution from 2G to 3G and 3G to 4G - Circuit Switch to Packet Switch - ITU Standardization Process- - Evolution of LTE and releases. **(9)**

INTRODUCTION TO 5G

Motivation for 5G - 5G targets - Technology components - Spectrum - capabilities - The role of 3GPP in standardization - use cases - 5GPPP (Public-Private Partnership) **(9)**

5G RADIO ACCESS NETWORK

Radio access - 3GPP Releases - 5G New Radio (NR) - Requirements - 3GPP phases for IMT-2020 - NR air interface - 5G RAN architecture **(9)**

5G SERVICES

Enhanced Mobile Broadband (eMBB) systems - Massive Machine Type Communication (MMTC) system - Ultra Reliable and Low Latency Communication (URLLC) systems - Design approaches **(9)**

EMERGING TECHNOLOGIES IN 5G

Massive MIMO - Network Function Virtualization - Software Defined Networking - Cognitive radio -Millimetre Wave - Heterogeneous network - Internet of Things **(9)**

TOTAL : 45

TEXT BOOKS

1. Saad Asif, "5G mobile Communications Concepts and Technologies", CRC Press,2018

2. Biljana Badic, Christian Drewes, Ingolf karls, Markus Mueck, "Rolling out 5G Use cases, Applications and Technology Solutions", Apress, 2016

REFERENCES

1. Antti Toskala, Harri Holma, Takehiro Nakamura, "5G Technology 3GPP New Radio", Wiley & Sons Ltd. 2020.

2. Devaki Chandramouli, Juho Pirskanen, Rainer Liebhart, "5G for the Connected World", Wiley,2019

3. Haesik Kim, "Design and Optimization for 5G Wireless Communications", Wiley, 2020

4. Ramjee Prasad, "5G Outlook Innovations and Applications", River Publications, 2016

5. Anwer Al-Dulaimi, "5G Networks Fundamental Requirements, Enabling Technologies, and Operations Management", Wiley, 2018

6. Mauro Boldi, Olav Queseth, Patrick Marsch, Ömer Bulakci, "5G System Design Architectural and Functional Considerations and Long Term Research", Wiley,2018

19ECEOE09 - VEHICULAR COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Understand basic principles, technologies, and system architecture of vehicular ad-hoc networks (VANET)*

CO2 : *Analyze Physical Layer and MAC Layer for signal propagation for vehicular communication*

CO3 : *Describe the various routing mechanisms and protocols to fulfill vehicular networking requirements.*

CO4 : *Explain the challenges and issues in establishing cellular V2X connection and mobility management.*

CO5 : *outline vehicular communication platforms for various emerging applications*

INTRODUCTION TO VEHICULAR RADIO NETWORKS

Basic principles and challenges-Mobile Wireless Communications and Networks-Need for Vehicular Communications-VANET activities- Network Architecture for Vehicular Communications. **(9)**

PHYSICAL LAYER AND MAC LAYER

Signal Propagation-Doppler spread and its impact on OFDM Systems-Proposed MAC approaches and standards, Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC **(10)**

VANET ROUTING PROTOCOLS

Opportunistic packet forwarding-topology based routing- geographic routing **(8)**

VEHICULAR MOBILITY MANAGEMENT

Connected Vehicles& Connected Autonomous Vehicles- Dedicated Short Range Communication-flow and traffic models-Standards and Regulations- DSRC Protocol Stack, Cellular V2X **(9)**

EMERGING VANET APPLICATIONS

Vehicle to Infrastructure Safety Applications-communication paradigms-message coding and composition-data aggregation-Security and Privacy **(9)**

TOTAL : 45

TEXT BOOKS

1. *H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and Inter-Networking Technologies, John Wiley & Sons Ltd., 1st Edition 2010.*

2. *Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy", John Wiley & Sons Ltd 1st Edition 2012.*

REFERENCES

1. *P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.*

2. *C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.*

3. *Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication",Springer,2010.*

4. *M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information Science Reference, 2010.*

5. *H. Moustafa, Y. Zhang, Vehicular Networks: Techniques, Standards, and Applications, CRC Press, 2009.*

6. *Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015*

19ECEOE10 - SENSING FOR AUTOMOTIVE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Acquaint with the basic automotive system components and need for automotive sensors.*

CO2 : *Discuss the fundamentals of various Power train sensors in automotive systems.*

CO3 : *Comprehend various sensors for chassis management.*

CO4 : *Understand the sensors for vehicle management & security systems in Automobiles.*

CO5 : *Examine the vehicle communication protocols standards in automotive applications.*

AUTOMOTIVE SYSTEMS

Introduction to Modern Automotive Systems- Electronics in Automobiles - Combustion Engines- Power-train- braking systems - Transmission- Applications and Challenges in the automotive. **(9)**

POWERTRAIN AUTOMOTIVE SENSORS

Exhaust temperature sensor - λ sensors - PM sensor - NOx sensor - fuel quality sensor- level sensor- torque sensor-speed sensor- manifold pressure sensor - mass flow sensor. **(9)**

CHASSSIS SENSORS

Wheel speed sensors/direction sensors- steering position sensor (multi turn)- acceleration sensor (inertia measurement)- brake pneumatic pressure sensor- ABS sensor- electronic stability sensor. **(9)**

SENSORS FOR VEHICLE MANAGEMENT & SECURITY SYSTEMS

Gas sensors (CO_2)- Temperature/humidity sensor- air bag sensor- key less entering sensor- radar sensors. Tire pressure monitoring systems- Two wheeler and Four wheeler security systems. **(9)**

VEHICLE COMMUNICATION STANDARDS

Automotive Protocols : CAN, LIN, FLEXRAY, MOST **(9)**

TOTAL : 45

TEXT BOOK

John Turner, Automotive Sensors, 2010, Momentum Press, 1ˢᵗ Edition, New York.

REFERENCES

1. *Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5ᵗʰ Edition, BOSCH.*

2. *Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2ⁿᵈ Edition 1999.*

3. *Automotive Sensors Handbook, 8ᵗʰ Edition, 2011, BOSCH*

4. *Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, Iwao Yokomori, "Sensors for Automotive Technology", 4ᵗʰ Edition, Wiley, New York, 2010.*

5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5ᵗʰ Edition, 2009.*

19CSOE01 - CUSTOMER RELATIONSHIP MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *State the evolution of marketing and define CRM architecture explaining customer acquisition, retention and segmentation.*

CO2 : *Describe the business value, its costs and deploying data mining for CRM.*

CO3 : *Understand the type of collecting and connecting the customer data with proper guidelines for privacy.*

CO4 : *Demonstrate the scoring process and apply the various CRM optimization techniques to optimize the CRM process in order to improve customer profitability.*

CO5 : *Evaluate CRM tools using tool assessment and methodology to choose the appropriate tool for real time applications.*

INTRODUCTION

Most profitable Customer - CRM: Custom centered database, Managing campaigns, Evolution of marketing, Closed loop marketing, CRM architecture - Customer profitability - Customer acquisition - Cross selling - Customer retention - Customer segmentation. **(9)**

BUILDING THE BUSINESS CASE

Introduction - Uncovering the needs for data mining - Defining the business value - The costs - Deploying Data mining for CRM: Introduction - Define the problem - Define the user - Define the data - Scope the project - Trial - Quality assurance - Education Launch - Continuation. **(10)**

COLLECTING CUSTOMER DATA

Introduction - Three types of customer data - Collecting customer data - Connecting customer - Customer data and privacy - Privacy and data mining - Guidelines for privacy - Legal issues associated with data mining. **(8)**

SCORING YOUR CUSTOMER

Introduction - Process - Scoring architectures and configurations - Preparing the data - Integrating scoring with other applications- Optimizing the CRM process: Introduction - Improved customer profitability through optimization - Optimized CRM - Complete loop - Optimal CRM process - Optimization techniques. **(8)**

OVERVIEW OF DATA MINING AND CRM TOOL MARKETS

Introduction - Data mining market place - Taxonomy of data mining tools - Tool assessment attributes and methodology - Tool evaluation -Data mining tool: WEKA -CRM tools - Next generation for CRM. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.*

2. *Ian H.Witten ,Eibe Frank, Mark A.Hall, "Data Mining Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Fourth Edition, 2016*

REFERENCES

1. *Francis Buttle, Stan Maklan "Customer Relationship Management: Concepts and Technologies", Routledge, Fourth Edition, 2019.*

2. *Roger J. Baran, Robert J. Galka, "CRM: The Foundation of Contemporary Marketing Strategy", S.Chand (G/L) & Company Ltd, Second Edition, 2017.*

19CSOE02 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the various software life cycle models and choose an appropriate model for a given application.*

CO2 : *Identify the functional requirements, prepare data flow, ER diagrams and Software Requirement Specifications.*

CO3 : *Employ suitable architectural styles, software design methodologies, coding standards and practices in developing practical applications*

CO4 : *Discuss various testing techniques and their application in defect removal.*

INTRODUCTION

The Software Engineering Discipline - Software Development Projects - Software Life Cycle Models: Use of Life Cycle Models - Classical Waterfall Model-Iterative Waterfall Model-Prototype model-Evolutionary Model-Spiral Model   **(9)**

SOFTWARE REQUIREMENTS AND ANALYSIS

Requirements Analysis and Specification - Requirements Gathering and Analysis- Value of good SRS - Requirement process- Requirement Specification - desirable characteristics, components and Structure of requirements document - Functional Specification with use cases - basics - developing Use Cases -DFDs - Data Dictionary - ER Diagrams.   **(8)**

SOFTWARE DESIGN

Design concepts - Cohesion and Coupling- The Open-Closed Principle - Function Oriented Software Design : Structured charts - Structured design methodology - Detailed Design: Logic / Algorithm design - State Modeling of Classes.   **(10)**

CODING

Programming principles and guidelines - Structured programming - Information hiding - Some programming practices - Coding standards - Code inspection - Planning- Self review - Group review meeting.   **(7)**

TESTING

Testing Fundamentals -Black Box Testing: Equivalence Class Partitioning - Boundary Value Analysis - White box Testing: Control Flow based criteria - Data Flow based Testing - Levels of Testing: Unit Testing - Integration Testing - System Testing - Acceptance Testing.   **(11)**

TOTAL : 45

TEXT BOOKS

1. *Pankaj Jalote, "Software Engineering A Precise Approach", Wiley India, Third edition 2012.*

2. *Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Private Limited, Third Edition 2013.*
   (Introduction only)

REFERENCES

1. *Roger.S.Pressman "Software Engineering A Practitioner's Approach", McGraw Hill International Edition, Seventh Edition, 2014.*

2. *Ian Sommerville, "Software Engineering", Dorling Kindersley (India) Private Ltd., Eighth Edition, 2008*

19CSOE03 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Gain knowledge in overview of www and web based applications.*

CO2 : *Design and develop dynamic and Interactive web page using DHTML.*

CO3 : *Design and develop web applications using servlets.*

CO4 : *Gain knowledge on E-business models and E-marketing.*

BASIC WEB CONCEPTS

Basic Web Concepts - Web based Client/Server model -Web Protocols- Working of web browser - Browser & Server Communication - Review of HTML: Markup Languages, Introduction to HTML- forms - frames - tables. **(9)**

CLIENT SIDE PROGRAMMING

Client-side Programming (Review of JavaScript): Introduction, Writing Comments, Variables, Operators, Statements, Alert, Confirm, and Prompt Boxes, Functions, Event and Error Handling, Introduction to Built-in Classes, Form Validation, Cookies. **(9)**

DYNAMIC HTML

Dynamic HTML :Introduction - cascading style sheets-object model and collections - event model - filters and transition - data binding - data control - ActiveX control - handling of multimedia data. **(9)**

SERVER SIDE PROGRAMMING

Servlets - Deployment of simple servlets - Web server (Java web server / Tomcat / Web logic) - HTTP GET and POST requests - Session tracking - Cookies - JDBC - Simple web applications - Multi-tier applications. **(9)**

WEB BASED APPLICATIONS AND ITS TECHNOLOGIES

Rails: Overview of Rails-Ajax: Overview of Ajax Rails with Ajax- e-Business Models-e-Marketing-online payments-Security.**(9)**

TOTAL : 45

TEXT BOOKS

1. *Deital & Deital, "Internet and World Wide Web-How to Program", Pearson Education Fifth Edition, 2011.*

2. *Robert W.Sebesta, "Programming with World Wide Web", Pearson Education, Eighth Edition, 2015.*

REFERENCES

1. *Scot Johnson, Keith Ballinger, Davis Howard Chapman, "Special Edition Using Active Server Pages", Prentice Hall of India, paperback 1999.*

2. *Ravi Kalakota and Andrew B Whinston, "Frontiers of e-commerce", Addison Wesley, paperback 1999.*

3. *Jeffrey C. Jackson," Web Technologies: A Computer Science Perspective", Pearson Education, Reprint 2011.*

4. *Elliotte Rusty Harold, "Java Network Programming", O'Reilly Publishers, Fourth Edition 2013.*

19CSOE04 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the basic concepts, architecture, data models of database management systems and data warehouse.*

CO2 : *Demonstrate the multidisciplinary fields of data mining and illustrate the techniques for data preprocessing.*

CO3 : *Find frequent item set and generate association rules for the given transactions.*

CO4 : *Analyze different types of data using classification and clustering techniques.*

BASIC CONCEPTS OF DATABASE SYSTEM

Purpose of DBMS - Applications - Views of data - Data Abstraction - Instances and Schemas - Data Models - Database Languages - Relational Databases - Database Architecture - Database users and administrators - History of Database systems.   **(8)**

DATA MINING

Data Mining - On What Kind of Data-Data Mining Functionalities - Classification of Data Mining Systems - Data Mining Task Primitives - Integration of a Data Mining System with a Database or Data Warehouse System-Major Issues in Data Mining.**(9)**

DATA WAREHOUSING

Data Warehouse - Introduction-Multidimensional Data Model-Data Warehouse Architecture -Data Warehouse Implementation from Data Warehousing to Data Mining.   **(8)**

DATA PREPROCESSING AND ASSOCIATION RULES

Data Preprocessing: Needs Preprocessing the Data - Data Cleaning- Data Integration and Transformation-Data Reduction-Discretization and Concept Hierarchy Generation. Association Rules: Basic concepts - Apriori Algorithm - Generation of association rules from frequent item sets - FP Tree Algorithm - Pattern evaluation methods   **(10)**

CLUSTERING AND CLASSIFICATION

Cluster analysis - Partitioning Methods - K-Means and K-Medoid algorithm - CLARA - CLARANS - Hierarchical clustering - BIRCH - Density based clustering - DBSCAN - Decision tree induction.   **(10)**

                                                                                                                     TOTAL : 45

TEXT BOOKS

1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Tata McGraw Hill, Sixth Edition, 2013. (Basic Concepts of Database System only)*

2. *Jiawei Han & Micheline kamber, "Data Mining-Concepts and Techniques" Morgan Kaufmann Publishers, Third Edition, 2012.*

REFERENCES

1. *Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.*

2. *Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.*

3. *Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh Indian Reprint New Delhi,2003.*

4. *George M. Marakas, "Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003*

5. *Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.*

19CSOE05 - INTRODUCTION TO EMBEDDED SYSTEMS

	L	T	P	C
	3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Examine the characteristics and challenges in embedded system development*

CO2 : *Identify the parameters affecting CPU performance and develop optimized code*

CO3 : *Demonstrate the scheduling of given set of real-time tasks using the appropriate scheduling algorithm*

CO4 : *Design embedded system for simple applications*

INTRODUCTION

Characteristics of embedded computing applications- Challenges in embedded computing design - Performance in embedded computing. Embedded System Design Process - Computer Architecture Taxonomy - ARM Processor -Assembly Language Programming. **(10)**

CPU PERFORMANCE

I/O Primitives - Busy -Wait I/O - Interrupts - Memory System Mechanisms: Cache, Memory Management Unit and Address Translation - Pipelining - CPU Power Consumption **(8)**

DEVELOPMENT AND DEBUGGING

Development environments - Debugging Techniques - Debugging challenges - System Level Performance analysis - Program Level Performance analysis - Program Optimization **(9)**

SCHEDULING

Scheduling states of a Process-Running Periodic Processes - Preemption - Priorities- Rate Monotonic Scheduling - Earliest Deadline First Scheduling - Priority Inversion - Data dependency. **(10)**

NETWORKS

Bus Standards: I2C, CAN Bus, Field Bus. CASE STUDY: Alarm Clock, Elevator Controller. **(8)**

TOTAL : 45

TEXT BOOK

1. *Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman, Third Edition, 2012*

REFERENCES

1. *Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education, First Edition, 2009. (For Scheduling)*

2. *David. E. Simon, "An Embedded Software Primer", Pearson Education, First Edition, 2012*

3. *Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, Third Edition, 2014.*

19ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Explain various schemes of number system representations, code conversions and perform arithmetic operations.*

CO2 : *Describe Boolean Algebra, formulate and simplify Boolean expressions using K-Maps and illustrate the logic gates realization.*

CO3 : *Describe the working of basic combinational circuits and sequential circuits.*

CO4 : *Describe the structure and functioning of various memory schemes.*

NUMBER SYSTEMS

Binary Numbers, Number Base Conversions, Octal and Hexadecimal Numbers.

Complements of Numbers - Signed Binary Numbers. Binary Codes : Binary-Coded Decimal (BCD) Code, Gray Code, ASCII Character Code, Error Detecting Code. BCD Addition - Decimal Arithmetic. Binary Storage and Registers.   **(9)**

BINARY LOGIC AND BOOLEAN ALGEBRA

Definition of Binary logic. Boolean Algebra - Basic Definitions - Theorems and Properties of Boolean Algebra - Canonical and Standard Forms. Digital Logic Gates : Integrated Circuits. Gate-Level Minimization: Map Method - Four Variable K-Map - Product of Sums Simplification. Realization of Boolean functions using Gates   **(9)**

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers.   **(10)**

SEQUENTIAL CIRCUITS

Storage Elements - Latches, Flip Flops - RS, D, JK and T flip -flops- Triggering of flip -flops - Characteristic Tables - Characteristic Equations. Registers - Shift Registers. Counters: Binary ripple counter - Up down binary counter.   **(9)**

MEMORY AND PROGRAMMABLE LOGIC

Random Access Memory - Memory Decoding - Read Only Memory - Types of ROMs, Programmable Logic Array, Programmable Array Logic   **(8)**

TOTAL : 45

TEXT BOOK

1. *M. Morris Mano and Michael D. Cieti,"Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth Edition, 2013.*

REFERENCES

1. *M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, First Edition, 2008.*

2. *Thomas L.Floyd, "Digital Fundamentals", Pearson Education, Tenth Edition, 2017.*

19ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the fundamental aspects of object oriented programming paradigm.*

CO2 : *Develop java programs using features like methods, classes, constructors, overloading and string handling.*

CO3 : *Write exception handling routines for practical applications.*

CO4 : *Describe multithreading, synchronization and networking features of Java.*

CO5 : *Demonstrate use of applets and database connectivity in developing practical Applications.*

OBJECT ORIENTED PROGRAMMING

Introduction to object oriented languages - Evolution of object oriented languages - Object oriented programming paradigm - Basic concepts of object oriented programming - Procedural Vs object oriented programming. **(6)**

INTRODUCTION TO JAVA

Java and Internet - Byte Code - Features of Java - Java Development Environment- Java Programming: Methods and Classes- Constructor - Garbage Collection - Overloading - Inheritance - Overriding - Packages and Interfaces - Java IO systems - String Handling : String and String Buffer. **(12)**

EXCEPTION HANDLING

Exception Handling: Fundamentals of Exception handling and types - Built in Exceptions - User defined Exceptions. **(5)**

MULTI THREADS

Multithreaded Programming: Thread Model -Thread properties -Thread priorities - Synchronization- Inter thread communication- Networking :Inet address- Datagrams - Sockets - URL connections. **(11)**

APPLET AND DATABASE CONNECTIVITY

Introduction to Abstract Window Tool kit - Applet class - HTML applet tags - Parameter passing - Audio clip interface - Event class: Keyboard and Mouse events handling. **(11)**

TOTAL : 45

TEXT BOOK

1. *Herbert Schilt :"Java 2 - Complete references ", Tata McGraw Hill, Ninth Edition, McGraw Hill Education, 2014.*

REFERENCE

1. *Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.*

19ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the database system concepts and explain the key features of Relational data models.*

CO2 : *Describe the features of Entity Relationship diagram and draw Entity Relationship diagram for the given real world application*

CO3 : *Design a normalized database system and carry out data retrieval using SQL.*

CO4 : *Demonstrate various transaction concepts and various concurrency control mechanisms*

DATABASE SYSTEMS

Data Vs Information-Introducing the database and DBMS- Importance of Database Design- Files and File systems-Problems with File System Data Management, Database Systems. Relational Database Model: Logical view of Data- Keys- Integrity Rules- Relational Set Operators- Data Dictionary and the system catalog -Codd's relational database rules.   **(10)**

RELATIONAL MODEL

Entity Relationship Model: Entities-Attributes-Relationship-Connectivity and cardinality- Existence Dependence-Relationship Strength-Weak Entities-Relationship participation- Relationship Degree-Recursive Relationship-Developing an ER Diagram.   **(8)**

STRUCTURED QUERY LANGUAGE

Introduction to SQL- Data Definition Commands- Data Manipulation Commands-Advanced Data Definition and SELECT Commands - Virtual Tables -Creating Views- Joining Database Tables.   **(8)**

DATABASE DESIGN

Database Tables and Normalization- Need for Normalization- Normalization Process- Improving the Design-Surrogate Key Considerations, High level Normal Forms, Normalization and Database Design-Denormalization.   **(10)**

TRANSACTION MANAGEMENT

Transaction Concepts: Transaction Properties- Transaction Concurrent Executions. Concurrency control with Locking Methods: Lock Granularity-Lock Types-Two-Phase Locking to Ensure Serializablity-Deadlocks-Database Recovery Management-RAID.

(9)

TOTAL : 45

TEXT BOOK

1. *Peter Rob, Coras M.Colonel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth Edition, 2012.*

REFERENCES

1. *Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.*

2. *Ramez Elmasri, Shamkant B. tJavathe, "Fundamentals ofDatabase Systems", Pearson Education, Sixth Edition, 2013.*

3. *Raghu Ramakrishnan, Johannes Gehrke, "Database ManagementSystems", McGraw Hill Education, Third Edition, 2014.*

4. *Thomas M.Connolly and Carolyn E.Begg, "A Practical Approach to Design, Implementation and Management", Pearson, 6th Edition, 2004.*

19ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Understanding the client- server, distributed collaborative and cloud computing architecture along with cloud storage and services.*

CO2 : *Classify the different virtualization environments and techniques.*

CO3 : *Illustrate various services deployed from a cloud architecture supported by different providers.*

CO4 : *Analyze the major security challenges and privacy problems in the cloud and virtual environment.*

INTRODUCTION

Understanding Cloud Computing- history of cloud computing: Client/Server computing, Peer to peer computing, Distributed computing and Collaborative computing.- Understanding cloud architecture, cloud storage and services-Pros and cons of cloud computing. **(9)**

VIRTUALIZATION

Introduction-Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization - Technology Examples **(9)**

CLOUD COMPUTING ARCHITECTURE

Cloud reference model: Architecture, Infrastructure / Hardware as a service, Platform as a service-Software as a service, Types of cloud: Public clouds, Private clouds, Hybrid Cloud, Community Clouds. **(9)**

CLOUD SERVICES

Discovering Cloud services Development services and tools: Amazon, Google App Engine, IBM, Salesforce.com, Other Cloud Services development tool **(9)**

CLOUD SECURITY

Security Overview - Cloud SecurityChallenges - Software as a Service Security - Security Governance - Risk Management - Security Monitoring - Security Architecture Design - Data Security - Application Security - Virtual Machine Security. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Michael Miller "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online",1st Edition, Pearson Education, New Delhi, 2009.*

2. *Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013. (Virtualization, Cloud Computing Architecture)*

3. *John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010. (Cloud Security)*

REFERENCES

1. *Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.*

2. *Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2002.*

3. *Kai Hwang, Geoffrey C Fox,Jack GDongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2002.*

19ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Identify and analyze the security threats and attacks and applydevice suitable security policies and standards.*

CO2 : *Assess the risks and apply suitable risk control strategies.*

CO3 : *Employ appropriate intrusion detection and prevention systems to ensure information security.*

CO4 : *Discuss various national and international laws of information security and its framework.*

INTRODUCTION, NEED FOR SECURITY

Introduction to Information Security - The History of Information Security- Critical Characteristics of Information - NSTISSC Security Model - Components of an Information System - Securing Components - Balancing Information Security and Access - The Systems Development Life Cycle - The Security Systems Development Life Cycle. The Need for Security: Introduction Business Needs First -Threats -Attacks. **(5)**

RISK MANAGEMENT AND INFORMATION SECURITY

Introduction - An Overview of Risk Management - Risk Identification -Risk Assessment - Risk Control Strategies - Selecting a Risk Control Strategy - Risk Management Discussion Points - Recommended Practices in Controlling Risk. **(6)**

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001and itscontrols, NIST SecurityModels, Design of Security Architecture - Security Education, Training and Awareness Program - Continuity Strategies. **(6)**

SECURITY TECHNOLOGY

Introduction - Intrusion Detection and Prevention Systems: IDPS Terminology, Use of IDPS, Strengths and Limitations of IDPS - Honey Pots, Honey Nets, and Padded Cell Systems - Scanning and Analysis Tools, Access Control Devices **(8)**

BIOMETRIC CONTROLS

Biometrics - Nature of Biometrics Identification/Authentication Techniques - Biometric Techniques - Matching and Enrollment Process in Biometrics - Benefits Over Traditional Authentication Methods. **(6)**

SECURITY OF WIRELESS NETWORKS

Attacks on Wireless Networks: Other Security Risks in Wireless Networks, Management and Mitigations for Wireless Networks Attacks. **(7)**

LAWS AND LEGAL FRAMEWORK

Introduction - Information Security and the Law: The Rising Need -Understanding the Laws for Information Security:A Conceptual Framework - The Indian ITAct - Laws for Intellectual Property Rights (IPR) -Health Insurance Portability and Accountability Act (HIPAA) - Building Security into Software/System Development Life Cycle. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Course Technology, New Delhi, Fourth Edition, 2012 Reprint.*

2. *Nina Godbole, "Information Systems Security-Security Management, Metrics, Frameworks and Best Practices", Wiley India Pvt. Ltd., New Delhi, First Edition, 2009.(Biometric Controls, Security of Wireless Networks, Laws and Legal Framework)*

REFERENCES

1. *Thomas R.Pettier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.*

2. *Vicki Krause and Harold F.Tipton, "information Security Management Handbook", Auerbach Publications, Sixth Edition, 2008.*

3. *Mark Merkow and Jim Breithaupt,"Information Security - Principles & Practices", Second Edition, Pearson Education, 2014.*

19ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the importance and need for effective user friendly Graphical User Interfaces (GUI).*

CO2 : *Choose suitable interactions devices/tools to meet application specific requirements.*

CO3 : *Design Graphical User Interfaces(GUI) using apt components and apply the design guidelines for user-friendly navigation and presentation.*

CO4 : *Asses graphical user interfaces for compliance against the screen design guidelines.*

INTRODUCTION

Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design **(9)**

THE GRAPHICAL USER INTERFACE & DESIGN PROCESS

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface.

Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions. **(9)**

SCREEN DESIGNING

Design Goals - Screen Planning and Purpose - Organizing Screen Elements - Ordering of Screen Data and Content - Screen Navigation and Flow - Visually Pleasing Composition - Amount of Information - Focus and Emphasis - Presenting Information Simply and Meaningfully - Information retrieval on web - Statistical Analysis - Technological considerations in Interface Design. **(9)**

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of DevicesBased on Screen Based Controls. Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. **(11)**

SOFTWARE TOOLS AND INTERACTION DEVICES

Specification Methods - Interface Building Tools - Keyboard and Function Keys - Pointing Devices Speech Recognition. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.*

2. *Ben Shneidermann, "Designing the User Interface", Fifth edition, Pearson Education Asia, 2013. (Software Tools and Interaction Devices)*

REFERENCE

1. *Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition*

19ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Describe the operational aspects of ERP system and its related technologies.*

CO2 : *Demonstrate the steps required for ERP Project management and implementation process by choosing the right vendors/consultants, employee training and monitoring.*

CO3 : *Categorize the business modules of an ERP package in order to define the functionality of various departments in a company.*

CO4 : *Analyze the ERP market place and its vendors, and assess how Enterprise Application Integration (EAI), e-business help the company use ERP to its utmost benefit.*

INTRODUCTION

Enterprise - An Overview - Introduction to ERP - Benefits Of ERP - ERP and Related Technologies - Business Process Reengineering (BPR) - Data Warehousing - Data Mining - OLAP--SCM.   **(9)**

ERP IMPLEMENTATION

ERP Implementation Lifecycle - Implementation Methodologies - ERP deployment methods - Package Selection - Process Definition - Vendors and Consultants - Contract with Vendors, Consultants and Employees - Training and education- Project Management and Monitoring.   **(10)**

THE ERP BUSINESS MODULES

Business modules of an ERP Package - Finance - Manufacturing - Human Resources - Plant Maintenance - Materials Management - Quality Management - Sales and Distribution.   **(9)**

THE ERP MARKET & ERP - PRESENT AND FUTURE

ERP Marketplace and Marketplace Dynamics - ERP Vendors - SAP AG, Oracle Corporation, Microsoft Dynamics, EPICOR, QAD, RAMCO Systems - Enterprise Application Integration (EAI)- ERP and E-Business- Future Directions and Trends in ERP.   **(9)**

SAP

Gateway to SAP: Architecture of SAP R/3 -SAP Integrated-Three Tier Architecture - SAP Easy Access - Understanding ABAP Workbench   **(8)**

TOTAL : 45

TEXT BOOKS

1. *Alexis Leon, "ERP Demystified", Tata McGraw Hill, New Delhi, Third Edition, 2014.*

2. *Dreamtech Press, "SAP R/3, Black Book", Dreamtech Software Team, 2006. (SAP)*

REFERENCES

1. *Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2011.*

2. *Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.*

19CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Practice the safety norms and inspect turning machines, boring machines, milling machine, planning machine, grinding machines, CNC machines and wood working machinery to create risk free working environment.*

CO2 : *Assess the adequacy of machinery guarding to eliminate or reduce the hazards from the point operation, flying chips and sparks and moving parts.*

CO3 : *Apply the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes, etc.,*

CO4 : *Predict, identify and evaluate, hazardous conditions and practices safety rules in in cold forming and hot working of metals*

CO5 : *Employ the safety rules in inspection and testing process and take plan the preventive measures in health and welfare of workers' aspects in engineering industry.*

SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. **(9)**

PRINCIPLES OF MACHINE GUARDING

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS - guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entry to hazardous installations-benefits of good guarding systems **(9)**

SAFETY IN WELDING AND GAS CUTTING

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipment and instruments - safety in generation, distribution and handling of industrial gases-colour coding - flashback arrestor - leak detection-pipeline safety-storage and handling of gas cylinders. **(9)**

SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. **(9)**

SAFETY IN FINISHING, INSPECTION AND TESTING

Heat treatment operations, electro plating, paint shops, sand and shotblasting, safety in inspection and testing, dynamic balancing, hydrotesting, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal

monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal **(9)**

TOTAL : 45

TEXT BOOKS

1.   *Wells G.L.,R.M.C. Seagrave-Flow sheeting for safety, Indian Institute of Chemical Engineering, London U.K,1977.*

2.   *TrevurKletz Butterworth, Learning from accidents, - London, 1988.*

3.   *John Barton and Richard Rogers, Chemical reaction Hazards - A guide to safety, Institution of Chemical Engineering London, 1997.*

4.   *Philip Hagan "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13th edition 2009.*

REFERENCES

1.   *Rohatgi A.K, Safety handling of Hazardous Chemicals Enterprises, Bombay, 1986.*

2.   *Shukla S.K., Envirohazards and Techno Legal aspects, Shashi Publications, Jaipur India, 1993.*

3.   *John V.Grimaldi and Rollin H.Simonds," Safety Management", Richard D Irwin, 1994.*

4.   *Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.*

5.   *"The Indian boilers act 1923 with amendments", Law Publishers (India) Pvt. Ltd., Allahabad.*

6.   *"Health and Safety in welding and Allied processes", Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.*

7.   *"Safe use of wood working machinery", HSE,UK,2005.*

19CHOE02 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Identify individual hazards in a process and deduce the associated risks.*

CO2 : *Identify radiation intensity and effects of explosion*

CO3 : *Perform risk analysis of various types of problems*

CO4 : *Evaluate effect about key hazard identification techniques*

CO5 : *Apply risk analysis techniques and Hazop study*

INTRODUCTION AND DISPERSION MODELS

Risk analysis introduction, quantitative risk assessment, rapid risk analysis - Comprehensive risk analysis - Emission and dispersion - Leak rate calculation. Single and two-phase flow - Dispersion model for dense gas - Flash fire - Plume dispersion - Toxic dispersion model - Ealuation of risk. **(9)**

RADIATION INTENSITY

Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people and property radiation VCVCE - Explosion due to over pressure - Effects of explosion, risk contour -Effects, explosion, BLEVE - Jet fire - Fire ball.**(9)**

RISK ANALYSIS

Overall risk analysis - Generation of meteorological data - Ignition data - Population data - Consequences analysis and total risk analysis - Overall risk contours for different failure scenarios - Disaster management plan - Emergency planning - On site and off site emergency planning, risk management ISO 14000, EMS models case studies - Marketing terminal, gas processing complex, refinery. **(9)**

HAZARD ANALYSIS

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough - Mexico - Madras - Vizag - Bopal analysis **(9)**

CASE STUDIES

Hazop - Guide words, parameters, derivation - Causes - Consequences - Recommendation - Coarse Hazop study - Case studies - Pumping system - Reactor - Mass transfer system. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ragavan K.V., Khan A.A., Methodologies in Hazard identification and assessment -Manual, CLRI publication, 1990.*

2. *Marcel.V.C., Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.*

3. *Skeleton B., Process Safety Analysis, Institution of chemical Engineers, U.K., 1997.*

REFERENCE

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

19CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Outline the green technology concepts and relevance in twenty first century requirements.*

CO2 : *Defend the environmental and sustainability issues, role of CSR and CER and Indian corporate structure and environment.*

CO3 : *Recall the indicators of sustainability and their use and can also find the alternate theories.*

CO4 : *Criticize the environmental reporting, ISO 14001, ISO 14064, financial initative by UNEP, etc.*

CO5 : *Analyse the green tax incentives and rebates, business redesign and its models.*

INTRODUCTION

The concept of green technology; evolution; nature, scope, importance and types; developing a theory; green technology in India; relevance in twenty first century. **(9)**

SUSTAINABILITY & ENVIRONMENT

Organizational environment; internal and external environment; Indian corporate structure and environment; how to go green; spreading the concept in organization; environmental and sustainability issues for the production of high-tech components and materials, life cycle analysis of materials, sustainable production and its role in corporate social responsibility (CSR) and corporate environmental responsibility (CER). **(9)**

ECOSYSTEM APPROACHES

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories **(9)**

ACTS OF GREEN TECHNOLOGY

Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy technology; green product technology. **(9)**

GREEN ECONOMICS

Definition; green techniques and methods; green tax incentives and rebates (to green projects and companies); green project technology in action; business redesign; eco-commerce models. **(9)**

TOTAL : 45

REFERENCES

1. *Green Technology and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida, 2008.*

2. *Green Marketing and Technology: A global Perspective by John F. Whaik, 2005.*

3. *The Green Energy Technology Book by Leo A. Meyer.*

4. *Green Project Technology by Richard Maltzman and David Shiden.*

5. *Green Marketing by JacquelinOttman.*

6. *Green and World by Andrew S. Winston.*

19CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Classify the types of corrosion and theories and also relate the various controlled corrosion process.*

CO2 : *Examine the factors involved in the corrosion and control methods of various corrosion.*

CO3 : *Analyse the mechanism of corrosion and evaluate the effects like pH, temperature, flow rate on corrosion.*

CO4 : *Design and develop the corrosion control methods like cathodic protection, sacrificial anode and impressed current anodes and anodic protection.*

CO5 : *Predict the different corrosion testing, monitoring and inspection tests by surface analytical studies.*

INTRODUCTION

Introduction, classification, economics and cost of corrosion. emf series, galvanic series, corrosion theories derivation of potential Current relations of activities controlled and diffusion controlled corrosion process. Potential - pH diagram, Fe-H2O system, application and limitation. Passivation - Definition, anodic passivation theory of passivation, oxidation laws, effects of oxygen and alloying on oxidation rates. **(9)**

CORROSION CONTROL METHODS

Forms of corrosion - Definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, fretting corrosion, hydrogen embitterment, corrosion processes and control methods in fertilizers, petrochemical, chemical building industries **(9)**

MECHANISM OF CORROSION

Environmental aspects, atmospheric corrosion - Classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature, and flows rates on corrosion, marine corrosion, underground corrosion. Biological corrosion, definition, mechanism of corrosion, control of bio-corrosion. **(9)**

CORROSION PREVENTION

Corrosion control aspects, electrochemical methods of protection-theory of cathodic protection design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - Boiler water system. Organic coating, surface preparation, natural, synthetic resin, paint, formulation and application. Design aspects in corrosion prevention, corrosion resistant materials. **(9)**

CORROSION TEST

Corrosion testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion processes, inspection methods by NDT. Surface analytical techniques such as AES, ESCA, SEM. Evaluation of paints by conventional and electrochemical methods. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Roberge P. R., Corrosion Engineering, McGraw Hill, New York, 2008.*

2. *Fontana M.G., Greene N.D., Corrosion Engineering, Third Edition, McGraw Hill, NewYork, 2005.*

3. *Uhling H. H., Revie R.W., Corrosion and Corrosion Control, John Wiley and Sons, Inc, 1985.*

REFERENCE

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

19CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Express the fundamentals of chemical engineering and to solve problems.*

CO2 : *Ability to develop basic fluid concepts, transfer and separation operations.*

CO3 : *Design equipment for transport and separation processes.*

CO4 : *Apply material and Energy balance to precisely calculate material required for a process.*

CO5 : *Apply steady state balances to develop process flow sheets.*

OVERVIEW OF CHEMICAL ENGINEERING

Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry-scope, features & characteristics. Flow sheets, and symbols for various operations. **(9)**

MATERIAL AND ENERGY BALANCE CALCULATIONS

Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances, combustion reactions. **(9)**

BASIC FLUID CONCEPTS

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics. pipe flow, Pumps, Agitation and Mixing, Compressors. **(9)**

HEAT TRANSFER OPERATIONS

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, natural and forced convection, correlations; Radiation; Heat exchangers- Fundamental principles and classification of heat exchangers, Evaporators. **(9)**

MASS TRANSFER OPERATIONS

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process. Energy and Mass Conservation in process systems and industries. Introduction to chemical reactors. **(9)**

TOTAL : 45

REFERENCES

1. *G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th Ed., McGraw Hill, 1984.*

2. *W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill, 2001.*

3. *R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd Ed., John Wiley, New York,2004.*

4. *L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill, 1961.*

5. *H.S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.*

19CHOE06 - NANOMATERIAL SYNTHESIS AND CHARACTERIZATION LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *To synthesize several nanomaterials in different methods in lab scale.*

CO2 : *To understand and operate the instruments for material characterization.*

CO3 : *To interpret the properties of synthesized nanomaterials by analyzing the results*

EXPERIMENTS

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol.

2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge.

3. Synthesis of ceria nanofibres by Solvothermal method.

4. Synthesis of silica nanoparticles using Stober method.

5. Synthesis of Au nanoparticles by simple chemical method.

6. Synthesis of Fe_3O_4 nanoparticles by simple reduction method.

7. Effect of reducing agent on the synthesis of metal nanoparticles.

8. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption.

9. Effect of concentration on the synthesis of silver nanoparticles.

10. Effect of reducing agent on gold nanoparticles.

11. Fabrication of silver nanofilms.

12. Synthesis of polyvinyl alcohol fibres by electrospinning method.

13. Synthesis of Au and Ag nanoparticles at aqueous-organic liquid interface; UV-visible spectroscopy of the colloidal film; comparison with the corresponding colloidal sol.

14. Sol gel synthesis of $ZnO/TiO_2/CdO$ nanoparticles.

15. A bioroute to Au nanoparticles.

16. Sol-gel spin coating route to SnO_2 nanothin films: surface roughness measurement by AFM.

17. Hydrothermal synthesis of ZnS Nanorods: Nanorods formation by SEM analysis.

18. Fabrication and wettability characterization of nanostructured soft polymer surfaces.

19. Preparation of nanofluids.

20. Determination of viscosity of nanofluids.

21. Evaporation studies of nanofluids.

22. Measurement of stability of nanofluids.

23. Optical properties of nanofluids.

24. Measurement of onset of natural convection in nanofluids.

25. Thermal conductivity measurement of nanofluids.

TOTAL : 60

REFERENCES

1. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*

2. *Vincenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai, Heat Transfer Enhancement with Nanofluids, CRC Press, 2017.*

3. *Amy S., Thermal Energy Storage Using Phase Change Materials: Fundamentals and Applications Fleischer, Springer, 2015.*

4. *Mohsen Sheikholeslami and Davood Domairry Ganji, Applications of Nanofluid for Heat Transfer Enhancement, Elsevier, 2017.*

5. *S.M. Sohel Murshed, Carlos Nieto de Castro, Nanofluids: Synthesis, Properties and Applications, Nova Science Publishers, 2014.*

6. *T. Pradeep, A Textbook of Nanoscience and Nanotechnology. Tata McGraw-Hill Education, 2003.*

7. *P.R. Chandran, M. Naseer, N. Udupa, N. Sandhyarani. Size controlled synthesis of biocompatible gold nanoparticles and their activity in the oxidation of NADH. Nanotechnology. 8, 23(1), 2011.*

8. *I.A. Ibrahim, A.A. Zikry, M.A. Sharaf. Preparation of spherical silica nanoparticles: Stober silica. J. Am. Sci. 6(11), 985-9, 2010.*

9. *X. Chen, S.S. Mao. Titanium dioxide nanomaterials: synthesis, properties, modifications, and applications. Chemical reviews. 11, 107(7), 2891-959, 2007.*

10. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*

19CHOE07 - MULTIVARIATE STATISTICS LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Design experiments to obtain statistical principles of Univariate examples.*

CO2 : *Apply the concepts of statistics to draw conclusions from data*

CO3 : *Assess practical knowledge to carry out meaningful interpretation of data from real life*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXPERIMENTS

1. Point and Interval Estimation for Normal and Chi-Square Distribution using Excel and R.

2. Point and Interval Estimation for T-Distribution and F-Distribution using Excel and R.

3. K-means Clustering.

4. One-way ANOVA Model in Excel and R.

5. Linear Regression

6. Logistic Regression

7. Naive Bayesian Classifier

8. Decision Trees

9. Simulation of Principal component analysis using Excel and R.

10. Simulation of Fischer Discriminant Analysis using Excel and R.

11. Modeling the Change by Differential Equations using R and Excel.

12. Modeling the Change by Difference Equations using R and Excel.

13. Multivariate Normal & Hoteling's T2 Distribution.

14. Multivariate Analysis of Variance (MANOVA).

15. Correspondence Analysis using R.

TOTAL : 60

REFERENCES

1. *Apostol T.M. (1985) Mathematical Analysis, Narosa,Indian Ed.*

2. *Courant R. And John F. (1965) Introduction to Calculas and Analysis, Wiley.*

3. *Miller K.S. (1957) Advanced Real Calculas, Harper, New York.*

4. *Rudin, Walter (1976) Principles of Mathematical Analysis,McGraw Hill.*

5. *Malik S.C. (2005) Principles of Real Analysis, New Age International (p)Ltd.*

6. *Bartle R.G. (1976) Elements of Real Analysis*

19MOE01 - GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *The students will be able to understand the idea of graph theory and to solve the real time problem.*

CO2 : *To relate the Graph theory Algorithms' in their field of engineering and apply the same in the irrespective mainstream.*

CO3 : *To become familiar with Special graphs for modeling the networks.*

CO4 : *Able to design and solve Coloring concepts for defined problems.*

CO5 : *Model the networks using graph theory.*

GRAPHS ANDSUB GRAPHS

Graph-Standard Concepts in Graphs - Sub graphs - Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix-Walk, Trail and Path - Bipartite Graph - Connectedness - The Shortest Path Problem - Dijkstra's Algorithm

(9)

TREES

Trees- Characterization - Blocks - Block Graphs - Cayley's Formula - Spanning Trees - Spanning Tree Algorithms - Kruskal's and Prim's Algorithm **(9)**

EULERIAN AND HAMILTONIAN GRAPHS

Eulerian graphs - Euler's theorem - Hamiltonian graphs - Dirac's and Ore's theorems - Closure of a graph - Bondy -Chvatal theorem - Traveling salesman problem - The Chinese Postman Problem - Fleury's Algorithm. **(9)**

COVERING AND COLORING

Covering - Independent Sets - Matching - Perfect Matching- Applications - The Personal Assignment Problem - Coloring - Chromatic Number - Four Color Problem - Chromatic Polynomials - Application. **(9)**

DIRECTED GRAPHS

Digraph - orientation - strongly, weakly and unilaterally connected digraphs - directed acyclic graph - adjacency matrix and incidence matrix of graph - Network Flows - Transport Networks - Max - Flow Min-Cut Theorem - Activity Network **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gary Chatrand and Ping Zhang, Introduction to Graph Theory, Mc Graw Hill Education (India), 2017.*

2. *Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India Private Limited, 2004.*

REFERENCES

1. *Douglas B.West, "Introduction to Graph Theory" Second Edition, Prentice Hall of India Private Limited, 2001.*

2. *Balakrishnan. R, Ranganathan. K , "A Text book of GraphTheory", Second Edition, Springer Newyork, 2012.*

3. *Clark. J. and Holton. D.A, "A First Look at GraphTheory", Allied Publishers,1995.*

4. *Frank Harary, Graph Theory, 10th Edition, Narosa Publishing House, 2001.*

19MOE02 - METHODS OF APPLIED MATHEMATICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *The students will be able to understand the idea of integral equations and to solve the real time problems.*

CO2 : *To familiarize the students with basic concept of ordinary differential equations, special functions and solve problems associated with engineering applications.*

CO3 : *To achieve an understanding of the basic concepts of boundary value problems and characteristic function representations and method of solving them.*

CO4 : *Able to construct and solve a mathematical model for heat flow problems in real life situation*

CO5 : *Able to use the concepts of Calculus of variations and basic concepts for solving equations involving functional*

INTEGRAL EQUATIONS

Relation between integral and differential equations - Green's function. Fredholum's equation with separable Kernals Hilbert Schmidt theory, interactive methods for solving equations of second kind.   **(9)**

SECOND ORDER ORDINARY DIFFERENTITAL EQUATIONS AND SPECIAL FUNCTIONS

Singular points, Series solutions and the methods of Frobenius, Bessel Equation, Bessel Functions, modified Bessel functions and their properties, Ber and Bei functions.   **(9)**

BOUNDARY PROBLEMS AND CHARACTERISTIC FUNCTION REPRESENTATIONS

Sturm - Liouviller problems. Orthogonal functions and expansions in series of Orthogonal functions. Stodola and Vianello method for Sturm - Liouviller problems, Fourier - Bessel and Legendre Series   **(9)**

PARTIAL DIFFERENTITAL EQUATIONS

Linear and quasi - linear equations of the first and second order. Characteristics of first and second order linear equations. Heat flow equations. Problems in one, two and three dimensions - Fourier method.   **(9)**

INTEGRAL TRANSFORM METHODS

Calculus of variations - Variational notation, Constraints and Lagarangian multipliers, variable and points, Rayleigh - Ritz method.   **(9)**

TOTAL : 45

TEXT BOOKS

1. *M.K. Venkatraman, Higher Mathematics for Engineering and Science, Third Edition, The National Publishing Company, 2014.*

2. *F.B. Hildebrand: Advanced Calculus for applications second Edition (EEE).Prentice Hall of India P.Ltd., 2014.*

REFERENCES

1. *F.B. Hildebrand - Methods of Applied Mathematics, Second Edition. Prentice Hall of India P.Ltd., 2012.*

2. *David Borthwick : An introduction to partial differential equation Springer International Publishing 2017.*

3. *Mattias Blennow: Mathematical methods in Physics and Engineering, CRC Press, 2018.*

19MOE03 - LINEAR AND NON - LINEAR PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the idea of linear Programming problems and to solve the real time problems.

CO2 : To familiarize the students with basic concept of Transportation models and solve problems associated with engineering applications.

CO3 : To achieve an understanding of the basic concepts of Assignment problems and method of solving them.

CO4 : Able to construct and solve a Game theory models in real life situation

CO5 : Able to use the concepts of Non-linear Programming problems for solving Constrained and unconstrained equations.

LINEAR PROGRAMMING

Formulation of LPP - Graphical methods for two variables - The Simplex method - Artificial Variables Techniques - Big M - method - The Two Phase method - Dual Simplex Method **(9)**

TRANSPORTATION MODEL

Mathematical formulation of a Transportation problem - Methods for finding initial basic feasible solution - North West corner rule - Least cost method - Vogel's Approximation method - Modified distribution method - Degeneracy in Transportation problems. **(9)**

ASSIGNMENT PROBLEM

Mathematical formulation of an Assignment problem - Hungarian Method - Unbalanced Assignment Models -Maximization case in Assignment Problems - Restrictions in Assignments - Travelling Sales man Problem. **(9)**

GAME THEORY

Two person zero - sum Games - The Maxmini - Minimax Principle - Saddle Point and value of the game -Games without saddle points, Mixed Strategies - Matrix Oddment method for n×n games - Dominance Property - Graphical Method of 2×n or m×2 games. **(9)**

NON - LINEAR PROGRAMMING

Non - linear Programming Algorithm - Unconstrained Non - linear Algorithms - Constrained Non -linear Lagrange multipliers, Kuhn - Tucker optimality conditions. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Operations Research An Introduction, Eight Edition, Hamdy A .TAHA, Pearson Prentice Hall 2016, New Delhi.*

2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016, A.R Publications, Chennai.*

REFERENCES

1. *Kanti Swarup, P.K. Gupta and Man Mohan, " Operations Research", Sultan Chand & Sons, Educational publishers, New Delhi. 20th Edition, 2019.*

2. *Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", Mc Graw Hill, (India) Private Limited, India, 11th Edition, 2021.*

19MOE04 - PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *The students will be able to understand the basic probability problems and to solve the real time problems.*

CO2 : *To familiarize the students with basic concept of probability distributions and solve problems associated with engineering applications.*

CO3 : *To achieve an understanding of the basic concepts of Correlation and regression and method of solving them.*

CO4 : *Able to solve a signal processing problems by using random process concepts.*

CO5 : *Able to use the concepts of Correlation functions and Power spectral densities for solving Electrical and electronics problem.*

THEORY OF PROBABILITY

Sample Space, Events, Axioms of probability, Conditional probability, Independent events, Theorem of total probability, Baye's Theorem.   **(9)**

PROBABILITY DISTRIBUTIONS

Definition of Discrete and Continuous random Variables

Discrete distributions : Binomial, Poisson and Geometric - Properties and Simple problems

Continuous distributions : Normal, Uniform Exponential - Properties and Simple problems.   **(9)**

CORRELATION AND REGRESSION

Correlation -Meaning and scope of Correlation - Scatter diagram, Karl Pearson's co-efficient of Correlation, Spearman's Rank Correlation, Multiple Correlation and partial correlation - simple problems.

Regression Analysis - Meaning and Scope of regression - Regression in two variables - Uses of Regression.   **(9)**

RANDOM PROCESSES

Classification - Stationary process - Markov process - Poisson process - Random telegraph process.   **(9)**

CORRELATION FUNCTIONS AND POWER SPECTRAL DENSITIES

Auto Correlation functions - Cross Correlation functions - Properties - Power spectral density - Cross spectral density - Properties.

(9)

TOTAL : 45

TEXT BOOKS

1. *S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics, Tenth Revised Edition, 2020.*

2. *T. Veerarajan, Probability, Statistics and Random Processes, Second Edition, Tata Mc Graw - Hill 2017.*

REFERENCS

1. *Robert Hogg & Joseph McKean: Introduction to Mathematical Statistics, Pearson 8th Edition 2018.*

2. *Bhat, B. R.: Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International 2015.*

3. Cochran,W.G: Sampling Techniques, Wiley Eastern Private Limited, 2007.

4. Sukhatme, P.V. and Sukhatme, B.V.(1977) : Sampling Theory of Survey with Applications, Asia publishing House.

5. Rakesh Dube, "Higher mathematics for Engineering and Science" Manakin Press, 2018.

6. Ibe,O.C.,"Fundamentals of Applied Probability and Random processes", 2nd Edition, Elsevier, 2019.

7. Peyton Peebles, "Probability Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, NewDelhi, 2017.

19POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.*

CO2 : *Understand the different classes of nanomaterials.*

CO3 : *Identify the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.*

CO4 : *Outline the applications of nanotechnology and develop an ability to critically evaluate the promise of a nanotechnology device.*

BASICS OF NANOTECHNOLOGY

Introduction - Time and length scale in structures - Definition of a nanosystem - Dimensionality and size dependent phenomena - Surface to volume ratio - Fraction of surface atoms - Surface energy and surface stress- surface defects - Effect of nanoscale on various properties - Structual, thermal, mechanical, magnetic, optical and electronic properties. **(9)**

DIFFERENT CLASSES OF NANOMATERIALS

Classification based on dimensionality - Quantum Dots, Wells and Wires - Carbon based nano materials (buckyballs, nanotubes, graphene) - Metal based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites - Nanopolymers - Nano ceramics - Biological nanomaterials. **(9)**

SYNTHESIS OF NANOMATERIALS

Chemical Methods: Metal Nanocrystals by Reduction - Sol - gel processing - Solvothermal Synthesis - Photochemical Synthesis - Chemical Vapor Deposition (CVD) - Metal Oxide - Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling - Electrodeposition - Spray Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE). **(9)**

CHARACTERIZATION OF NANOSTRUCTURES

Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM) - Energy Dispersive X-ray analysis (EDAX) - Transmission Electron Microscope (TEM) - Scanning Tunneling Microscope (STM) - Atomic force microscopy (AFM), UV-vis spectroscopy (liquid and solid state) - Raman spectroscopy - X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy(AES). **(9)**

APPLICATIONS

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics - Polymers with a special architecture - Liquid crystalline systems - Applications in displays and other devices - Nanomaterials for data storage - Photonics, Plasmonics - Chemical and biosensors - Nanomedicine and Nanobiotechnology. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Nano technology: Basic Science and Emerging technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)*

2. *A Text book of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw Hill Education Pvt. Ltd., 2012.*

3. *Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, 2002.*

4. *Introduction to Nanotechnology, Charles P.Poole,Frank J.Owens, Wiley Interscience (2003)*

5. *Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Springer Science & Business Media, 2013.*

REFERENCES

1. *Nanotechnology: A gentle introduction to the next Big idea, Mark A.Ratner, Daniel Ratner, Mark Ratne, Prentice Hall P7R:1st Edition (2002)*
2. *Fundamental properties of nanostructed materials Ed D. Fioran, G.Sberveglier, World Scientific 1994*
3. *Dupas C., Houdy P., Lahmani M.,Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg, 2007*

19POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Recognize the fundamental growth and material parameters of thin films.*

CO2 : *Evaluate and use models for nucleation and growth of thin films.*

CO3 : *Asses the relation between deposition technique, film structure and film properties.*

CO4 : *Identify modern techniques for the characterization of thin films*

CO5 : *Demonstrate the applications of thin films*

Preparation of thin films : Preparation methods: electrolytic deposition, cathodic and anodic films, thermal evaporation, cathodic sputtering, chemical vapour deposition. Molecular beam epitaxy and laser abalation methods. Thickness measurement and monitoring: electrical, mechanical, optical interference, microbalance, quartz crystal methods. **(9)**

Growth Kinetics of Thin Films : General features.- nucleation theories - energy formation of a nucleus - critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped) Effect of electron bombardment on film structure. Post-nucleation growth, epitaxial films and growth. **(9)**

Analytical techniques of characterization : X-ray diffraction - Photoluminescence - UV-Vis-IR spectrophotometer - Atomic Force Microscope - Scanning Electron Microscope - Hall effect - Vibrational Sample Magnetometer - Secondary Ion Mass Spectrometry - X-ray Photoemission Spectroscopy - Auger emission spectroscopy. **(9)**

Properties of Thin films : Dielectric properties - experimental technique for the determination of dielectric properties - optical properties - experimental technique for the determination of optical constants - mechanical properties - experimental technique for the determination of mechanical properties of thin films - magnetic and superconducting properties. **(9)**

Applications : Optoelectronic devices : LED, LASER and Solar cell - Micro Electromechanical Systems (MEMS) - Fabrication of thin film capacitor - application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) - sensors - fabrication and characterization of thin film transistor and FET. **(9)**

TOTAL : 45

TEXT BOOKS

1. *A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi, 2006.*

2. *L.I. Maissel and Glang (Eds.), Handbook of Thin film Technology, McGraw-Hill, 1970.*

3. *K.L. Chopra, Thin Film Phenomena, McGraw-Hill (1983)*

REFERENCES

1. *Thin-Film Deposition : Principles and Practice, Smith Donald Donald L Smith Smith, McGraw-Hill Professional Pub, 1995*

2. *J.C. Anderson, The Use of Thin Films in Physical Investigation, Academic Press 1966.*

3. *J.J. Coutts, Active and Passive Thin Film Devices, Academic Press 1978.*

4. *George Hass, Physics of Thin Films: Volumes 1.:12, Academic Press 1963.*

5. *Kiyotaka Wasa, Makoto Kitabatake, Hideaki Adachi, Thin Films Material Technology, Springer-Verlag Berlin Heidelberg, 2004.*

19POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Demonstrate the knowledge about photovoltaics.*

CO2 : *Gain knowledge about principle of operation of solar cells*

CO3 : *Realization about semiconducting materials used in the manufacture of PV cells*

CO4 : *Outline the various advanced solar cell technologies, their current status and future technological challenges*

EVOLUTION OF SOLAR CELLS

Historical development; present and future global issues- commercialization/economic factors- basic components of PV systems - The solar spectrum - terrestrial and space spectra; air mass (AM0, AM1.5) - Introduction to 1st, 2nd and 3rd generation photovoltaics. **(9)**

SOLAR CELL FUNDAMENTALS

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell - light absorption- creating charge carriers forming the electric field - driving the charge carriers - solar cell parameters- electrical characteristics - the ideal solar cell, solar cell in practice, the quantum efficiency and spectral response, optical properties - basics of solar cell device design. **(9)**

SEMICONDUCTOR PROPERTIES

Overview of semiconductor properties relevant to solar cell operations- semiconductor band structure, carrier statistics in semiconductors, the transport equations, carrier mobility, carrier generation by optical absorption - band to band transitions, free-carrier absorption, recombination- bulk recombination processes, surface recombination, minority carrier life time. **(9)**

SILICON AND THIN FILM SOLAR CELLS

Si photovoltaics - single crystal silicon cells - semicrystalline and polycrystalline silicon cells - overview of various thin film solar cells: gallium arsenide solar cells - fabrication techniques, InP & cadmium telluride based solar cells - copper indium diselenide solar cells - multijunction cells - environmental and health aspects. **(9)**

ADVANCED SOLAR CELLS

Advanced solar cell concepts - organic (polymer) photovoltaics - new concepts - quantum dots, wires, intermediate band, multiple exciton generation - Dye sensitized solar cells - perovskite solar cells - challenges in materials and device design - current and future research trends in PV. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Fonash S. J., "Solar Cell Device Physics", Academic, 2010.*

2. *Goetzberger, J. Knobloch, and B. Voss "Crystalline Silicon Solar Cells" Wiley, 1998.*

3. *Green M. A. "Third Generation Photovoltaics: Advanced Solar Energy Conversion" Springer, 2006 .*

REFERENCES

1. *Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt. Ltd., 2009.*

2. *Jha A.R., "Solar Cell Technology and Applications", CRC Press, 2010.*

19POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Recognize the criteria for material selection based on properties of materials and to choose the required material for a specified application.*

CO2 : *Understand various metallurgical forming processes such as casting, rolling extrusion, drawing, development of grain structure and processing of different composite types.*

CO3 : *Demonstrate knowledge about powder metallurgy, ceramic and polymer processing methods.*

CO4 : *Identify and choose the required surface treatment technique for coating formation on account of enhancing the surface properties of the mechanical components for engineering applications.*

CO5 : *Understand the applicable joining and machining techniques and their limitations*

INTRODUCTION AND SELECTION OF MATERIALS

Motivation for selection - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability, corrosion and wear resistance - Relationship between materials selection and processing - Case studies - aero, auto, marine, machinery and nuclear applications. High and low temperature materials, superconductors, supramagnetic materials, high entropy alloys, nanomaterials and biomaterials. **(9)**

METALLURGICAL FORMING AND PROCESSING OF COMPOSITES

Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties. Processing of composites: lay up methods, press/ autoclave / resin transfer moulding, Reinforced Reaction Injection Molding (RRIM), obtrusion and filament winding. **(9)**

POWDER METALLURGY, CERAMIC AND POLYMER PROCESSING

Powder metallurgy and ceramic processing: green fabrication methods, sintering, hot pressing, Hot Isostatic Pressing (HIP), spark plasma sintering, development of microstructure in powder processed materials. Polymer processing: extrusion, injection moulding, blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers. **(9)**

COATING METHODS

Introduction to surface Engineering, Differences between surface and bulk properties, Properties of surfaces-wear, wettability. Chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes. Principle of various coating processes, process parameters, controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. **(10)**

JOINING AND MACHINING

Joining: fusion welding, solid state welding, adhesive bonding, mechanical joining and recent advancements in welding. machining: Electromachining (electrochemical and electro-discharge), mechanical machining and recent advancements. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials", 3rd Edition, Butterworth-Heinemann, 1977.*

2. *Betzalel Avitzu, "Metal Forming- Processes and Analysis", Tata McGraw Hill, 1977.*

3. *William F Hasford, Robert M Caddell "Metal Forming: Mechanics and Metallurgy" Cambridge University Press P. ltd, 2007.*

4. *Angelo P C and Subramanian R" Powder Metallurgy Science, Technology and Applications", Prentice Hall of India, New Delhi, 2012.*

REFERENCES

1. *Michael Barsoum, "Fundamentals of Ceramics", Mc Graw Hill Publishing Co., INC, 1997*

2. *Gowariker V R, Viswanathan N V, Jayadev Sreedhar, "Polymer Science", New Age International P Ltd., 2005.*

3. *David S. Rickerby, Allan Matthews "Advanced surface coatings: a handbook of surface engineering", Blackie, 1991.*

4. *Parmar, R.S, "Welding Engineering and Technology", Khanna Publishers, 2003.*

19COE01 - MEDICAL NANO TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : *Understand the essential features of nanomedicine*

CO2 : *Identify the medical based nanotools*

CO3 : *Assess health effects due to nanoparticle exposure*

ASSESSING NANOTECHNOLOGY HEALTH

Nanomaterials : The Current State of Nanotechnology Application - Nanotechnology Risks - Risk Analysis - Hazard Identification - Exposure Assessment for Nanomaterials - Risk Characterization - Risk Management - Best Practices for Nanomaterials in the Workplace - Safety Research - Needs for Engineered Nanoscale Materials **(9)**

RISK ASSESSMENT AND ENVIRONMENTAL PROTECTION

Context for Technological Risk - Need for Risk Assessment for Nanotechnology - Adaptive Risk Assessment for Nanomaterials - Origins and Development of Risk Assessment - Risk Assessment Used in Environmental Decision Making - Issues in Applying the Four Steps of Risk Assessment to Nanotechnology - Hazard Assessment - Exposure Assessment - Dose - Response Evaluation **(9)**

SUSTAINABLE NANOTECHNOLOGY DEVELOPMENT

Necessity of Risk Assessment in Nanotechnology - The Pace of Nanotechnology Development and the Paucity of Information - Potential for Wide Dispersion in the Environment Amid Uncertainty - Few Standards or Guidelines - Environmental Risk Issues - Carbon Nanotubes - Defining the Toxic Dose - Environmentally Friendly Nanotechnology - Life Cycle Analysis for Sustainable Nanotechnology **(9)**

HUMAN HEALTH, TOXICOLOGY, AND NANOTECHNOLOGY RISK

Mechanisms of Toxicity - Types of Toxicological Studies - Pulmonary Toxicity Studies - Gastro intestinal Toxicity - In Vitro Studies - Dermal - In Vitro Toxicity Studies **(4)**

ENVIRONMENTAL RISKS

Antimicrobial Properties of Nanoscale Silver - Buckyballs, Titanium Dioxide - Short-term Toxicity Tests - Daphnia LC50 Assays - Studies of Nanomaterial Toxicity to Fish - Buckyballs and Bass-TiO_2 in Arsenic - Field Studies - Environmental Exposures - Nanoscale Zerovalent Iron **(9)**

NANOELECTRONIC DEVICES

Resonant tunneling diodes - Field effect transistors - Single electron transfer devices - Potential effect transistors - Light emitting diodes and lasers - Nanoelectromechanical system devices - Quantum dot cellular automata **(5)**

TOTAL : 45

TEXT BOOKS

1. *George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007*

2. *Vladimir V. Mithin et.al, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications" Cambridge University Press, 2012*

REFERENCES

1. *Mithin.V, Kochelap.V and Stroscio.M, "Introduction to Nanoelectronics", Cambridge University Press, 2008*

2. *Karl Gosar et.al, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005.*

19COE02 - ADVANCED DRUG DELIVERY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *The students will be able to know the fundamentals of Nanoscience and their applications in pharamacological industries*

CO2 : *The students will able to describe polymeric drug delivery systems and their encapsulation methodology to study targeted drug delivery with different polymeric systems*

CO3 : *The students will able to identify lipids-nanocarriers and their application in biological system*

CO4 : *The students will able to study site specific drug delivery for gene therapy*

THEORY OF ADVANCED DRUG DELIVERY

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models. **(10)**

POLYMERS Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscafold systems Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA. **(8)**

LIPID BASED NANOCARRIERS

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes. **(9)**

MICROBES AND ANTIBODY BASED NANOCARRIERS

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibodybioconjugates. **(9)**

SITE SPECIFIC DRUG DELIVERY

Concepts and mechanism of Site specific drug delivery- Microneedles, Micropumps, microvalves. Implantable microchips.

(9)

TOTAL : 45

REFERENCES

1. *Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman, Oxford University Press, 2001.*
2. *Drug Delivery and Targeting, A.M. Hillery, CRC Press, 2002.*
3. *Drug Delivery: Principles and Applications, B. Wang, Wiley Intersceince, 2005.*
4. *Nanoparticle Technology for Drug Delivery, Ram B. Gupta, Uday B. Kompella Taylor & Francis, 2006.*

19COE03 - BIOSENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *The students will able to understand protein based biosensors and their enzyme reactivity, stability and their application in protein based nano crystalline thin film processing*

CO2 : *The students will able to describe DNA based biosensors to study the presence of heavy metals in the food products*

CO3 : *The students will able to understand fluorescence, UV-Vis and electrochemical applications of biosensors*

CO4 : *The students will able to study about the fabrication of biosensors and its application as nanochip analyzer*

PROTEIN BASED BIOSENSORS

Nano structure for enzyme stabilization - Single enzyme nano particles - Nanotubes microporous silica - Protein based nano crystalline Diamond thin film for processing **(9)**

DNA BASED BIOSENSOR

Heavy metal complexing with DNA and its determination, water and food samples - DNA zymo biosensors **(9)**

ELECTRO CHEMICAL APPLICATION

Detection in biosensors - Flurorescence - Absorption - Electrochemical. Integration of various techniques - Fibre optic biosensors **(9)**

FABRICATION OF BIOSENSORS

Techniques used for microfabrication - Microfabrication of electrodes - On chip analysis **(9)**

BIOSENSORS IN RESEARCH

Future direction in biosensor research - Designed protein pores-as components of biosensors - Molecular design - Bionanotechnology for cellular biosensing - Biosensors for drug discovery - Nanoscale biosensors **(9)**

TOTAL : 45

REFERENCES

1. *Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004*

2. *Nanomaterials for Biosensors, Cs. Kumar, Willey - VCH, 2007*

3. *Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, CRC Press, 2006.*

19COE04 - NANOCOMPOSITES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : *Study the different synthesis techniques of metal ceramic nanocomposites and their functionality*

CO2 : *Describe the processing techniques for heterometallic nanocomposites and to study their electromagnetical property*

CO3 : *Understand the design of super hard nanocomposites with improved mechanical properties*

CO4 : *Study the polymer based carbon nanotube composites, to study their mechanical properties and their industrial applications*

NANO CERAMICS

Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. **(9)**

METAL BASED NANOCOMPOSITES

Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties. **(9)**

DESIGN OF SUPER HARD MATERIALS

Super hard nanocomposites, its designing and improvements of mechanical properties. **(9)**

NEW KIND OF NANOCOMPOSITES

Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites. **(9)**

POLYMER BASED NANOCOMPOSITES

Preparation and characterization of diblock Copolymer based nanocomposites; Polymercarbon nanotubes based composites, their mechanical properties, and industrial possibilities. **(9)**

TOTAL : 45

REFERENCES

1. *Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.*

2. *Physical Properties of Carbon Nanotubes- R. Saito 1998.*

3. *Carbon Nanotubes (Carbon, Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.*

4. *The search for novel, superhard materials- Stan Veprek (Review Article) JVST A, 1999*

5. *Electromagnetic and magnetic properties of multi component metal oxides, hetero*

6. *Nanometer versus micrometer-sized particles-Christian Brosseau,Jamal Ben, Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003*

7. *Diblock Copolymer, - Aviram (Review Article), Nature, 2002*

19COE05 - BIOREFINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : *Understand various renewable feedstocks for biofuels production*

CO2 : *Understand the broad concept of second and third generation biofuel products from biomass and other low-cost agri-residues and biowastes.*

CO3 : *Analyze the design processes for biofuel production*

CHEMISTRY & BIOCHEMISTRY OF BIOMASS

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; trichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch. **(9)**

BIODIESEL

Sources and processing of biodiesel, nature of lipids, fatty acids and triglycerides.Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel, (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. **(9)**

BIOMETHANE OR BIOGAS

Hydrolysis; anaerobic digestion; methanogenesis (acetoclastic, hydrogenotrophic), rates of methane formation; and one and two stage fermentation.Thermal depolymerization.Use of exhaust gases (e.g. CO_2, H_2S and H_2) from geothermal power plants and industrial operations (e.g. coal and oil refineries) as an energy sources (methane and hydrogen) **(9)**

GASIFICATION & PYROLYSIS TECHNOLOGIES

Gasification processes and the main types of gasifier designs; production of electricity by combining a gasifier with a gas turbine or fuel cell.Combined- cycle electricity generation with gas and steam turbines, and generation of heat and steam for district heating systems or CHP, including kalina Cycle. Production of synthesis gas (i.e. CO, H_2, H_2O, CO_2) tar vapor and ash particles) for subsequent conversion to hydrogen and transport fuels; advanced gas cleaning technologies for biomass. Biological conversion of syngas into liquid biofuels. Fast pyrolysis technology to produce a range of fuels, chemicals, and fertilizers; biorefineries, and new uses for glycerine in biorefineries. **(9)**

POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY

Analysis of both current and future EU regulations and directives on biofuels and bioenergy.Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Robert C.Brown, "Biorenewable Resourses: Engineering", New Products from Agriculture, Wiley- Blackwell Publishing, 2003.*

2. *Samir K.Khanal, "Anaerobic Biotechnology for Bioenergy Production: Principles and Application", Wiley- Blackwell Publishing 2008.*

REFERENCES

1. *Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery", Springer Publishing, 2008.*

19HOE01 - PRINCIPLES OF MANAGEMENT

COURSE OUTCOMES

CO1 : *Design the Management function for a given organization*

CO2 : *Design and develop a strategic approach for the completion of the project*

CO3 : *Analyze the behavior of individuals and groups in organizations in terms of the key factors*

CO4 : *Formulate the procedure for recruitment, selection, training of staff to establish an organization*

Unit I - Introduction to Management: Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought **(9)**

Unit II - Management Concepts: Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma **(9)**

Unit III - Organizational Behavior: Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work **(9)**

Unit IV - Business Process Reengineering: Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity **(8)**

Unit V - Human Resource Management: Evolution of Management- Development of Managerial skills-Human Resource Management - Objectives -Job analysis -Recruitment -Selection and Placement and Training Development **(10)**

TOTAL : 45

TEXT BOOKS

1. *Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, "Principles of Management" Tata Mcgraw Hill, New Delhi, 2013.*

2. *Mamoria, CB, "Personnel Management", Sultan Chand and Sons, New Delhi, 2013.*

REFERENCES

1. *Robbin Finchanm and Peter Rhodes, "Principles of Organizational Behavior" Oxford University Press, 2010.*

2. *CB Gupta "Management Theory and Practice" Sultan Chand and Sons, New Delhi, 2009.*

3. *VSP Rao "Management Text and Cases" Excel Books, New Delhi, 2009.*

4. *Fred Luthans "Organizational Behavior" Mc-Graw hill, New York, 2005.*

5. *Knanna OP "Industrial Engineering and Management", Dhanpat Rai publications, New Delhi, 2003.*

19HOE02 : CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : *Outline the structure of our Indian Economic System*

CO2 : *Access the role of industrial sector in Indian economy*

CO3 : *Interpret the demographic trends for the current scenario*

CO4 : *Analyze the role of two tier for the achievement of common national goals*

Unit - 1 National Income and Agriculture Sector: Economics Development-Meaning-National Income and Per capita Income in India- Indian Planning-Agricultural Development of India: Major crops- Production-Productivity-Contribution to GDP and Exports

(8)

Unit - II Industrial Sector: India's industrial development-Industrial policies of 1948, 1956 and 1991-Liberalisation-Public sector-Privatization-Disinvestment policy-Role and importance of large scale industries and small scale industries-Special economic zones-Contribution to GDP-Growth rate **(8)**

Unit - III Population: Growth and policy issues-Demographic trends-Vital statistics-India's population: size and growth rate-Demographic dividend-HDI-Population policy-Issues of Unemployment, Poverty and inequality in India **(10)**

Unit - IV Service sector: Service sector in India-Banking-Insurance-Telecommunication-IT sector-Software exports-BPO-Contribution to GDP **(9)**

Unit - V Federal System and Foreign Trade: Federal setup in India-Taxes: Direct and Indirect Tax-Value added Tax-Foreign direct investment-Merits and Demerits-India's imports and exports: Composition and direction-Foreign exchange reserve position-MNC's in India **(10)**

TOTAL : 45

TEXT BOOKS

1. *Ruddar Datt and Sundaram, KPM, Indian Economy, S.Chand and company, New Delhi-2015*

2. *Ramesh Singh Indian Economy, McGraw hill Education 7ʰ Edition, 2015*

References: www.jagranjosh.com

19H0E03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : *Evaluate the monetary measures formulated through static and dynamic role of money*

CO2 : *Design the driving force of circular flow of money*

CO3 : *Analyse how quantity theory of money fluctuate the price level*

CO4 : *Estimate the demand and supply of money based on the Interest rate*

Unit I Nature and significance of Money: Definition of Money-Functions of Money-Static and Dynamic role of Money-Circular flow of Money-Monetary standards-Gold standard-Paper currency standard-Principles of Note issue-Measures of Money supply **(9)**

Unit II Quantity Theory of Money: Fisher's quantity theory of Money-Assumptions-Cash Balance Approach (Cambridge Equations)- Equation of Marshall, Pigou and Keynes-Similarities and dissimilarities of cash balance and cash transaction approaches-Income and expenditure theory-Superiority of Income and expenditure theory-Demand for Money: Classical and Keynesian liquidity preference theory approach **(9)**

Unit III Inflation and Deflation: Meaning-Types-Causes of Inflation-Demand Pull and Cost push inflation -Inflationary Gap-Phillips Curve-Effects of Inflation-Deflation-Causes-Measures to control Inflation and Deflation-Stagflation **(9)**

Unit IV Commercial Banking and Financial Markets: Functions of Commercial Banks-Credit Creation-Meaning and constitute of Money Markets-Capital Market-Institutional structure of Capital Market-Primary Market-Secondary Market-Indian capital Market-Non-Banking financial intermediaries **(9)**

Unit V Central Banking and Monetary Policy: Central Banking-Functions-Organization-Instruments of Credit control-Monetary Policy: Meaning, Objectives, and Recent policy changes in RBI-Monetary Policy in a developing economy **(9)**

TOTAL : 45

TEXT BOOK

1. *Jhinghan ML "Monetary Economics:" Vrinda Publications, New Delhi, 2013.*

REFERENCES

1. *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi, 1996.*
2. *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai, 2013.*

19HOE04 - ENGLISH FOR ACADEMIC PURPOSE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : *Write a description and apply grammatical rules.*

CO2 : *Analyse a passage and enhance vocabulary.*

CO3 : *Formulate a research paper*

CO4 : *Listen to a lecture and prepare a summary.*

CO5 : *Construct dialogues using appropriate expressions.*

FOCUS ON LANGUAGE

Sentence construction- types of clauses- sequence- co ordination- subordination- paragraphing information - describing a system & procedure   **(9)**

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and megacities - To identify and outline main ideas in a passage - Skim a reading passage for main ideas - Summarize texts and images - Using a dictionary to obtain lexical, phonological and orthographical information - Identify and use target vocabulary words - Highlight important parts and texts.   **(13)**

WRITING

Achieving appropriate tone and style in academic writing - writing a Research article - Types of Research Designs - Choosing a Research Problem- The Abstract - The Introduction - The Literature Review - 6. The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proofreading.

LISTENING

Listening to conversation - lectures - topics - discussions - listening comprehension on specific topics - listening to recognize formal and informal spoken English   **(11)**

SPEAKING

Seminar skills - Engage in verbal role playing in Formal and Informal situation. - Express advice and personal opinions with supporting information - Paraphrase stories and information - Expressing requests - Suggestions - Complaints - Apology - Giving and Accepting compliments - Making invitations - Refusing invitations   **(12)**

TOTAL : 45

REFERENCES

1. *Wisniewska, I., Riggenbach, H.,& Samuda, V. (2007). Grammar dimensions*

2. *Form, meaning, and use (4th Ed.). Boston, MA: Heinele Cengage Learning Longman Introductory Course for the TOFEL Test*

3. *Original publications and web- based resources will be reviewed as necessary.*

19HOE05 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : *Listen to TOEFL exercises and formulate appropriate answers.*

CO2 : *Speak using right grammar and appropriate pronunciation on general and academic topics.*

CO3 : *Analyze the passage and answer the question.*

CO4 : *Generate and organize ideas on a given topic*

LISTENING

Listening to conversation - Narration - Suggestion - Assumptions - Predictions - Implications - Problems - Academic conversations - Discussions - Lectures **(11)**

SPEAKING

Independent speaking - Integrated speaking - Speaking about a personal experience - Preferences - Report the speakers opinion - Explain a problem and solution - Give a summary of a academic lecture. **(13)**

READING

Read and understand short passages - Integrated reading tasks - Read the passage and choose the right summary of the passage - Reading for main ideas - Scanning the passage for synonyms - Making inferences - Identifying exceptions - Locating references. **(12)**

WRITING

Independent writing - Integrated writing - Writing short essays - Writing dialogues - Articles - Sentence construction **(9)**

TOTAL : 45

REFERENCES

1. *Sharpe J.Pamela. Barron's How to prepare for the TOEFL Test of English as a foreign Language. 11th Edition, Galgotia Publications Pvt. Ltd: New Delhi, 2004.*

2. *Sharpe J.Pamela. Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*

19HOE06 - LIFE AND LITERATURE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : *Compose an essay on the prose piece*

CO2 : *Analyse the poem and write a critical appreciation of it*

CO3 : *Read the story and find the moral values implied in the stories*

CO4 : *Write a review the fiction*

Unit - 1 : Prose

The Postmaster by Rabindranath Tagore

Snapshot of a Dog by J G Thurber

On the Rule of the Road by A.G. Gardiner

The Village Schoolmaster by Oliver Goldsmith

Incident of the French Camp by Robert Browning (13)

Unit - 2 : Poems

Stopping By Woods on a Snowy Evening by Robert Frost

The Ballad of Father Gilligan by W.B. Yeats (9)

Unit - 3 : Short stories

The Model Millionaire by Oscar Wilde

The Ant and the Grasshopper by W. Somerset Maugham

The Doll's House by Katherine Mansfield, Biography

Albert Einstein and Steve Jobs (11)

Unit - 4 : Fiction

The Old Man and the Sea by Ernest Hemmingway

The Scarlet Pimpernel by Baroness Emma Orczy

Practice in creative writing, review writing (13)

TOTAL : 45

REFERENCES

1. *Xavier. ed. An Anthology of Popular Essays and Poems. Macmillan: New Delhi, 2009.*

2. *Kumara Pillai. ed. A Book of Modern Short Stories. Macmillan: New Delhi, 2009.*

3. *Colleen and Darius Krishnaraj. ed. Convergence , A Book of Short Stories. Macmillan: New Delhi, 2009.*

4. *Ernest Hemmingway. The Old Man and the Sea. Arrow: Warwickshire, 2000.*

5. *Baroness Emma Orczy, The Scarlet Pimpernel. Hutchinson : 1995.*