INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM

CURRICULUM AND SYLLABUS FOR THE COURSES OF B. TECH./B.TECH (HON)/DUAL DEGREE (B.TECH - MS) PROGRAMME IN ELECTRONICS AND COMMUNICATION ENGINEERING

B.TECH./B.TECH (HON)/DUAL DEGREE (B.TECH - MS) COURSE STRUCTURE
ELECTRONICS AND COMMUNICATION

Semester –I						Semester -II					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
IMA 111	Discrete Mathematics	3	1	0	4	IMA 121	Calculus and Linear Algebra	3	1	0	4
IEC 111	Electronic Circuits and Measurements	3	1	3	5	IEC 121	Digital Design and Electric Circuits	3	1	3	5
ICS 112	Computer Programming	3	1	3	5	ICS 121	Data Structures I	3	1	3	5
IEC 112	Network Theory	3	1	0	4	ICS 122	Computer Organization	3	1	0	4
IHS 111	Communication Skills	3	0	0	3	IEC 122	Principles of Communication	3	1	0	4
IHS 112	Foreign Language	1	0	0	1	IHS 121	Personality Development	1	0	0	1
IPT 111	Physical Training I	0	0	2	0						
Total		**16**	**4**	**8**	**22**	**Total**		**16**	**5**	**6**	**23**
Cumulative Credits at the End of First Year: 45											
Semester –III						**Semester -IV**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
IMA 211	Probability, Statistics, and Random Processes.	3	1	0	4	IEC 221	Digital Design with Hardware description languages	3	0	3	4
IEC 211	Control Systems	3	1	0	4	IEC 222	Digital Communication	3	0	3	4
IEC 212	Analog Integrated Circuits	3	0	3	4	IEC 223	Electromagnetic Theory	3	1	0	4
IEC 213	Microprocessors & Microcontrollers	3	0	3	4	ICS 224	Computer Networks	3	0	3	4
IEC 214	Signals and Systems	3	1	0	4	IMA221	Differential Equations and Transforms	3	1	0	4
IEC 215	Power Electronics and Instrumentation	3	0	0	3	IHS 221	Fundamentals of Economics	1	0	0	1
ICS 215	Data Structures II	1	0	3	2	IHS 222	Principles of Management	1	0	0	1
IPT 211	Physical Training II	0	0	2	0	ICS 225	Data structures III	1	0	3	2
Total		**19**	**3**	**11**	**25**	**Total**		**18**	**3**	**9**	**24**
Cumulative Credits at the End of Second Year: 94											
Semester –V						**Semester -VI**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
CSE 311	Artificial Intelligence	3	0	3	4	ECE 321	VLSI Design	3	0	3	4
CSE 313	Internet of Things	3	0	3	4	ECE 322	Embedded Systems	3	0	3	4
ECE 311	Digital Signal processing and its applications	3	0	3	4	IOE xxxx	Advanced Computer Architectures/ Computer Vision / Wireless Sensor networks/ Cloud computing	3	0	0	3
IMA 312	Information Theory and Coding	3	0	0	3	ECE xxxx	Advanced Communication Networks/ Automotive Electronics/ Nanoelectronics/Biomedical Signal Processing	3	0	0	3
ECE 312	Microwave Engineering	3	1	0	4	CSE 322	Machine Learning	3	0	3	4
IHS 311	Human Resource Management	1	0	0	1	ISC 321	High performance and Scientific Computing	3	0	0	3
IHS 312	Financial Management & Accounting	1	0	0	1	IEC 321	Honours Project I (Optional)				
IHS 313	Operations and Supply chain management.	1	0	0	1						
Total		**18**	**1**	**9**	**22**	**Total**		**18**	**0**	**9**	**21**
Cumulative Credits at the End of Third Year: 137											
Semester –VII						**Semester -VIII**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
ECE 411	FPGA based System Design	3	0	3	4	ECE xxxx	Data Compression/Design of Digital Integrated Circuits /Natural Language Processing/ Real time Embedded Systems	3	0	0	3
ECE 412	Antenna theory and Design	3	1	0	4	ECE xxxx	MEMS/ Wireless and Cellular Communication/ Multimedia Communication/ Radar Engineering/ Industrial training	3	0	3	4
ECE xxxx	Statistical Signal Processing/ Robotics and Automation/ Optical Communication Networks /Mixed Signal Design/ System-On-Chip Design	3	1	0	4	IOE xxxx	Deep Learning/ Error Control Coding	3	0	0	3
IOE xxxx	Cryptography and Network Security/ Optimization/ Detection and Estimation Theory	3	0	0	3	IEC 421	BTP II	6	0	0	6
IEC 411	BTP - I	6	0	0	6	IEC xxxx	Honours Project II (Optional)				
IEC xxx	Research Course(Optional)					IEC xxx	Research Course(Optional)				
Total		**18**	**2**	**3**	**21**	**Total**		**15**	**0**	**3**	**16**
Cumulative Credits at the End of Fourth Year:174 (B. Tech); 174+ 12=186 (B. Tech(Hon)); 174+20= 194(B. Tech- MS))											
Semester –IX						**Semester -X**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
IEC 511	Research Project	12	0	0	12	IEC 521	Research Project	12	0	0	12
Total		**12**	**0**	**0**	**12**	**Total**		**12**	**0**	**0**	**12**
Cumulative Credits at the End of Fifth Year: 218 (B. Tech-MS)											

Remark: *To meet the minimum requirement of 186 credits for qualifying the BTech (Hon) Degree, students may take two additional projects of 6 credits each and, to meet the requirement of 218 credits for BTech-MS, students may take two additional projects of 6 credits each, two 4 credit research courses and 24 credit research project in addition to 174 credits requirement of BTech Degree.*

B.TECH./B.TECH (HON)/DUAL DEGREE (B.TECH – MS) PROGRAMM

Sl No	Course Description	Minimum Credits Requirement			Period
		BTech	BTech (Hon)	BTech-MS	
1	Institute Core courses	94	94	94	Semester I to IV
2	Bouquet Core Courses	24	24	24	Semester V to VIII
3	Stream Electives	18	18	18	Semester V to VIII
4	Institute Open Electives	9	9	9	Semester V to VIII
5	Humanities Electives	3	3	3	Semester V to VIII
6	Science Electives	3	3	3	Semester V to VIII
7	Maths Electives	3	3	3	Semester V to VIII
8	Engineering Elective	4	4	4	Semester V to VIII
9	Any other elective/Industrial Training	4	4	4	Semester V to VIII
10	BTech Projects	12	12	12	Semester VII to VIII
11	Honours Project		12	12	Semester VI to VIII
12	Research Courses			8	Semester VII to VIII
13	Research Project			24	Semester IX to X
Total Credits required for Successful Completion		**174**	**186**	**218**	
Minimum CGPA required for Successful Completion		**5.5**	**8.0**	**8.0**	

Table of Contents

SEMESTER I

IMA 111 Discrete Mathematics [3-1-0-4]

Objectives of the course

- To extend student's Logical and Mathematical maturity and ability to deal with abstraction
- To introduce most of the basic terminologies used in electronics and communication engineering courses
- To explain and apply the basic methods of discrete mathematics in electronics and communication engineering.
- To able to write clear, concise and correct mathematics proofs.
- To solve counting problems involving permutations and combinations and apply Pigeon hole principle
- To understand the basics of graph theory and group theory

Outcomes of the course

- Have knowledge of the concepts needed to test the logic of a program.
- Have an understanding in identifying structures on many levels.
- Be aware of a class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.
- Be able to apply basic counting techniques to solve combinatorial problems
- Acquire ability to describe computer programs in a formal mathematical manner.

Syllabus

Logic: Propositions, negation, disjunction and conjunction, implication and equivalence,

truth tables, predicates, quantifiers, rules of inference, methods of proof.

Set theory: definition and simple proofs in set theory, Inductive definition of sets and

proof by induction, inclusion and exclusion principle, relations, representation of relations

by graphs, properties of relations, equivalence relations and partitions, partial orderings, linear and well-ordered sets.

Functions: mappings, injection and surjections, composition of function, inverse functions, special functions, recursive function theory.

Elementary combinatorics: Counting techniques, pigeonhole principle, recurrence relation, generating functions.

Graph theory: Elements of graph theory, Euler graph, Hamiltonian path, trees, tree traversals, spanning trees.

Algebra: groups, Lagrange's theorem, homomorphism theorem, rings and fields, structure of the ring Zn and the unit group Zn*, lattice.

Textbooks/References

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Seventh Edition, Mcgraw-Hill, 2017.
2. Norman L. Biggs, Discrete Mathematics, Oxford University Press, Second Edition, 2003.
3. J.P. Tremblay, R. Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill,2017.
4. K.A. Ross, C.R. B. Wright, Discrete Mathematics, 5th Edition, Pearson, 2003.
5. P. B. Bhattacharya, S. K. Jain, S, R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press,2003.
6. J.A. Gallian, Contemporary Abstract Algebra, Ninth Edition, Cengage Learning, 2017.

IEC 111 Electronic Circuits and Measurements [3-1-3-5]

Course Objectives

- Understand the physics behind electronic device operations
- Understand operating principles of basic electronic devices including p-n junction, metal-semiconductor contact, bipolar junction transistors and field effect transistors
- Analyse and evaluate the performance of basic electronic devices

- Understand the construction and working principles of optoelectronic devices
- Understand the fabrication process of semiconductor devices and CMOS process integration.

Course Outcomes

- Learn the theory describing the carrier behaviour in semiconductors.
- Have knowledge on the energy band structures and their significance in electric properties of solids
- Analyse p-n junction at equilibrium and under bias
- Analysis of metal-oxide-semiconductor field effect transistors (MOSFETs) and bipolar junction transistors (BJTs) including the equilibrium characteristics, modes of operation, switching and current amplifying behaviour

Syllabus

Semiconductors: Bonding forces in solids, Energy bands, Metals, Semiconductors and Insulators, Direct and Indirect semiconductors, Electrons and Holes, Intrinsic and Extrinsic materials, Conductivity and Mobility, Drift and Resistance, Effects of temperature and doping on mobility, Hall Effect.

Forward and Reverse biased junctions- description of Current flow at a junction, reverse bias, Reverse bias breakdown- Zener breakdown, avalanche breakdown, Diode Applications, Rectifiers, Clipping and Clamping Circuits. Zener Diodes as regulators

Optoelectronic Devices: Photodiodes - Current and Voltage in an Illuminated Junction, Solar Cells, Photodetectors. Light Emitting Diode: Light Emitting materials

Bipolar Junction Transistors: Fundamentals of BJT operation, Amplification with BJTS, BJT Fabrication, The coupled Diode model (Ebers-Moll Model), Switching operation of a transistor, Cutoff, saturation, switching cycle, specifications, Drift in the base region, Base narrowing, Avalanche breakdown.

Field Effect Transistors Basic pn JFET Operation, Equivalent Circuit and Frequency Limitations, MOSFET- Two terminal MOS structure- Energy band diagram, Ideal Capacitance – Voltage Characteristics and Frequency Effects, Basic MOSFET Operation- MOSFET structure, Current-Voltage Characteristics.

Fabrication of p-n junctions Thermal Oxidation, Diffusion, Rapid Thermal Processing, Ion implantation, chemical vapour deposition, photolithography, Etching, metallization.

Integrated Circuits Background, Evolution of ICs, CMOS Process Integration, Integration of Other Circuit Elements.

Lab Practice

Familiarization of Basic Electronic Lab Equipments, Familiarization of Diodes, Testing.

Diode characteristics, Diode Circuits: Rectifiers, Regulators, Clipping and Clamping Circuits.

Transistor characteristics, MOSFET Characteristics

Text Books/References

1. Ben. G. Streetman, Sanjay Kumar Banergee, “Solid State Electronic Devices”, 7thEdition, Pearson Education, 2016, ISBN 978-93-325-5508-2.
2. Donald A Neamen, Dhrubes Biswas, “Semiconductor Physics and Devices”, 4th Edition, MCGraw Hill Education, 2012, ISBN 978-0-07-107010-2.
3. S. M. Sze, Kwok K. Ng, “Physics of Semiconductor Devices”, 3rd Edition, Wiley, 2018.
4. A. Bar-Lev, “Semiconductor and Electronic Devices”, 3rd Edition, PHI, 1993.
5. David A Bell, Electronic Devices and Circuits, Oxford University Press, Fifth Edition, 2008.
6. Sedra A. and Smith K. C, Microelectronic Circuits”, Oxford University Press, Sixth Edition, 2011.
7. Robert. L. Boylestad, Louis Nashelsky, Electronic Devices and Circuits Theory, Pearson Education, Eleventh Edition, 2015.

8. Jacob Millman and Christos. C. Halkias, Electronic Devices and Circuits, Mc. Graw Hill, Fourth Edition, 2015.
9. Albert Malvino and David J Bates, Electronic Principles, Seventh Edition, McGraw Hill, 2006

ICS 112 Computer Programming [3-1-3-5]

Course Objectives

- To introduce the problem-solving processes and techniques
- To teach computer programming
- To use C & C++ for solving the problems

Course Outcomes

1. Students learn how to write the sequence of operations in solving a problem
2. Students learn to translate the problem solving steps to a program
3. Students learn the use of programming language for solving real world problems on a computer

Syllabus

Basics of computers: software/ systems, Programming- Introduction, Problem solving- Introduction, Problem solving techniques: definition of problems, solutions, top-down approach, breaking problem in to sub-problems.

Algorithms: - writing the steps required solving problems, representing algorithms as flowchart, translating to procedure/ functions. Modularity

Example problems: computation of factorial, sine, Mod arithmetic-computation of quotient/ remainder, solving factorial through recursion, etc. Object technology- introduction, C++ data types/ scope rules, C++ control statements, Example problems/ program, Example problems/ program, Character handling, Pointers, functions, Classes and objects, Classes and objects

Lab Practice

Implement fundamental domain knowledge of the course for developing effective computing solutions by incorporating creativity and logical reasoning.

Students are encouraged to use the lab sessions as a multi-use, technology-enhanced teaching space with characteristics of both classrooms and labs.

Understand and learn how a big program can be broken up into independent modules and define functions and call them with appropriate parameters.

Students should gain a clear idea of how decision making and various basic/advanced constructs for control flow and instruction repetition is done while programming.

Students should learn how to use arrays for storing/retrieving large amount of data. They should also understand the concept of strings and string libraries used for their manipulation.

Comprehend how to use structures as a compound datatype. Students should also acquire the capability to design structures according to their requirement.

Understand recursion, pointer referencing/dereferencing and dynamic allocation of memory.

Text Book/References

1. R G Dromey, How to Solve It by Computer, Prentice-Hall International Series in Computer Science, 2006.
2. G.Michael Schneider, Invitation to Computer Science, Eighth Edition, 2018.
3. Byron S Gotrified, Programming with C, Thrid Edition, McGraw Hill Companies, 2017.
4. Michael Vine, C Programming for the Absolute Beginner, Third Edition, 2014.
5. Brian W Kernighan, Dennis M. Ritchie, C Programming Language, Second Edition, Pearson Education India, 2015.
6. Herbert Schildt, C++ Complete Reference, McGraw Hill, Fourth Edition, 2017.
7. Eric Nagler, Learning C++: A hands-on Approach, Third Edition, Cengage learning, 2017.

IEC 112 Network Theory [3-1-0-4]

Course Objectives

This course will enable students to

- Describe basic network concepts emphasizing source transformation, source shifting, mesh and nodal techniques to solve for resistance, voltage, current and power.
- Explain Thevenin‘s, Millman‘s, Superposition, Maximum Power transfer and Norton‘s Theorems and apply them in solving the problems related to Electrical Circuits.
- Explain the behavior of networks subjected to transient conditions.
- Use applications of Laplace transforms to network problems.
- Study two port network parameters like Z, Y, T and h and their inter-relationships and applications.
- Study of RLC Series and parallel tuned circuit.

Course Outcomes

At the end of the course students will be able to

- Determine currents and voltages using source transformation/ source shifting/ mesh/ nodal analysis and reduce given network using star-delta transformation/source transformation/ source shifting.
- Solve network problems by applying Superposition/ Reciprocity/ Thevenin‘s/ Norton‘s/ Maximum Power Transfer/ Millman‘s Network Theorems and electrical laws to reduce circuit complexities and to arrive at feasible solutions.
- Calculate current and voltages for the given circuit under transient conditions.
- Apply Laplace transform to solve the given network
- Solve the given network using specified two port network parameter like Z or Y or T or h
- Understand the concept of resonance

Syllabus

Basic Concepts: Practical sources, Source transformations, Network reduction using Star – Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks.

Network Theorems: Superposition, Millman‘s theorems, Thevinin‘s and Norton‘s theorems, Maximum Power transfer theorem.

Transient behavior and initial conditions: Behavior of circuit elements under switching

condition and their Representation, evaluation of initial and final conditions in RL, RC and

RLC circuits for AC and DC excitations.

Laplace Transformation & Applications: Solution of networks, step, ramp and impulse

responses, waveform Synthesis.

Two port network parameters: Definition of Z, Y, h and Transmission parameters, modelling

with these parameters, relationship between parameters sets.

Resonance: Series Resonance: Variation of Current and Voltage with Frequency, Selectivity and Bandwidth, Q-Factor, Circuit Magnification Factor, Selectivith with Variable Capacitance, Selectivity with Variable Inductance. Parallel Resonance: Selectivity and Bandwidth, Maximum Impedance Conditions with C, L

and f Variable, current in Anti-Resonant Circuit, The General Case-Resistance Present in both Branches.

Text Book/References

1. M.E. Van Valkenberg (2000), ―Network analysis‖, Prentice Hall of India, 3rdedition, 2000, ISBN: 9780136110958.
2. Roy Choudhury, ―Networks and systems, 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677
3. Hayt, Kemmerly and Durbin, Engineering Circuit Analysis, TMH 7th Edition, 2010.
4. J. David Irwin /R. Mark Nelms, Basic Engineering Circuit Analysis, John Wiley, 8thed, 2006.

5. Charles K Alexander and Mathew N O Sadiku, Fundamentals of Electric Circuits, Tata McGraw-Hill, 3rd Ed, 2009.

IHS 111 Communication Skills [3-0-0-3]

Course Objectives

The objective of the course is to improve the English communication skills of First Semester B. Tech students who had just passed out of their Senior Secondary classes. This is challenging since the class included students from various parts of the country speaking various mother tongues.

The syllabus is designed to give importance to essential grammar, as well as reading, writing and speaking skills. Based on this, work in class consisted of teaching grammar, interspersed with written exercises, reading practice, reading comprehension, business letter writing, report writing, training in preparing CV for job applications, group discussion and extempore speaking. The classes were rounded off with some training in the so called “soft skills”.

Course Outcomes

At the end of the sessions, improvement in English language ability was noted in most of the students. A large number showed very good improvement, while even the least competent registered some improvement. Under the circumstances, the objective of the class would appear to have been achieved.

Syllabus

Communication, verbal and non-verbal, Conversation: formal and informal, prepared and extempore, English: British/American/Indian, Vocabulary development: reading, use of dictionaries, Expression: writing, Pronunciation: phonetics, use of phonetic dictionaries, speaking, English grammar: Basics: Parts of speech: Noun, Pro-noun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection .Verb: Tenses. Sentence structure: S+V.Concord: Subject-Verb agreement.Reported speech,Active and passive voice, Tag questions, Confusing words and expressions,Synonyms and antonyms,Idioms and phrases, Common errors in English,Punctuation.Writing skills: Letters: Formal/Informal, Reports,CV. Comprehension: Listening/Reading/Making notes/ Summarising, Interview skills, Group discussion,Soft-skills.

Text Book/References

1. A.J. Thomson & A.V. Martinet.A Practical English Grammar. Delhi: OUP.
2. George Yule.xford Practice Grammar: Advanced.Oxford:OUP.
3. Raymond Murphy.Essential English Grammar. Delhi: Cambridge University Press.
4. Mathew Monippally.The Craft of Business Letter Writing. New Delhi: Tata McGraw-Hill.

IHS 112 Foreign Language [1-0-0-1]

SEMESTER II

IMA121 Calculus and Linear Algebra [3-1-0-4]

Course Objectives

- To Study the basic topological properties of the real numbers
- Have the knowledge of the sequence of real numbers and convergence.
- Studying the notion of continuous functions and their properties.
- To gain an understanding of the linear system of equations
- To get introduced to the fundamental concepts of vector spaces
- To impart the basics of linear transformation, orthogonalization, basis, dimensions and eigenvalues.
- To provide the knowledge to apply the concepts of linear algebra in engineering applications

Course Outcomes

- Have a good knowledge of the mathematical concepts in real analysis
- Be able to prove statements and to formulate precise mathematical arguments.
- To solve the problems related to linear systems and matrices
- To apply the knowledge of linear transformation, orthogonal projections, ortho-normalization and Least-square solutions in engineering applications.

Syllabus

Calculus: The Natural Numbers,The Peano axioms; Real Numbers; Properties of Real Numbers; Least upper bound and greatest lower bound properties: Sequences and Series: Convergence and limit laws, Finite and infinite series, Sums of non-negative numbers, Absolute and conditional convergence of an infinite series, tests of convergence; Continuous function on R: left and right continuity, examples of continuous and discontinuous functions, The Maximum principle, Intermediate value theorem, Monotonic functions, Uniform continuity. Differentiation of functions: Definition and basic properties, Local maxima, local minima, and derivatives, Monotone functions and derivatives, , Rolle's theorem, Mean value theorem: The Riemann Integration: Upper and lower Riemann integrals, Basic properties of Riemann integral, Riemann integrability of continuous functions, monotone functions, and discontinuous functions, The fundamental theorems of calculus

Linear Algebra: Fields, System of linear equations, Matrices and elementary row operations, Row reduced echelon matrices, Matrix multiplication, Invertible matrices, Rank of a matrix. Definition of a linear vector space and examples; linear independence of vectors, basis and dimension, Subspaces; Linear transformations

Isomorphism, Linear functionals, the double dual; Inner product, orthogonal basis, Gram-Schmidt orthogonalization process; linear operators; Orthogonal and Hermitian matrices, Eigen vectors of a matrix and matrix diagonalization, Applications

Text Books/References

1. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, Fourth Edition, Wiley, 2011.
2. T. M. Apostol, Calculus, Volume I, Second Edition, Wiley, 2007.
3. Gilbert Strang, Linear Algebra and Its Applications, 5 edition, Wellesley-Cambridge Press/Siam, 2016
4. K. Hoffman and R. Kunze, Linear Algebra, 2 edition, PHI, 2009
5. Erwin Kreyzig, Advanced Engineering Mathematics, Tenth Edition, Wiley, 2015.

IEC 121 Digital Design [3-1-3-5]

Course Objectives

- To provide the student with the fundamental concepts and skills necessary to analyse and design combinational and sequential logic circuits.
- To illustrate simplification of Algebraic equations using Karnaugh Maps and Quine-Mc-Clusky Techniques

- To design Decoders, Encoders, Digital Multiplexers, Adders, Subtractors and Binary Comparators.
- To describe Latches and Flip-flops, Registers and Counters.
- To develop state diagrams of Synchronous Sequential Circuits

Course Outcomes

After studying this course, students will be able to:

- Explain the concept of combinational and sequential logic circuits.
- Design combinational logic circuits.
- Design sequential circuits using SR, JK, D, T flip-flops
- Develop applications of Combinational & Sequential Circuits.

Syllabus

Review of Number Systems - Number systems and conversions-decimal, binary, 1's and 2's complements, hexadecimal, octal etc. Logic gates-NOT, AND, OR, XOR, XNOR, Universal gates, timing diagrams.

Boolean algebra: De Morgans theorems, SOP and POS forms. Karnaugh Maps-to simplify Boolean expressions, truth table functions. Combinational Logic-Analyse basic combinational logic circuits, design a combinational logic circuits for a given truth table. Functions of Combinational logic-comparators, adders, code converters, multiplexers, de-multiplexers.

Sequential Circuit Design - Flip-Flops and Latches. SR, D, and JK Flip-Flops. Edge-triggered and Master-Slave Flip-Flops, Excitation table. Counters – Design of asynchronous and synchronous counters. Timing diagrams up/down counters. Shift Registers – data movements in shift registers. SISO, SIPO, PISO, PIPO shift registers.

Memory and programmable logic – RAM, Memory decoding, ROM, PLA, PAL, sequential programmable devices, overview of logic design using Verilog HDL, Basic concepts, Modules, Ports.

Lab Practice

Familiarization of Logic Gates. Design of Combinational Logic Circuits – Comparators, Adders, Code Converters, Multiplexers, Demultiplexers etc. Familiarization of Flip-Flops and Latches. SR, D, and JK Flip-Flops. Edge-triggered and Master-Slave Flip-Flops. Design of Sequential Logic Circuits, Design of Counters, Asynchronous Counters, Synchronous counters. Shift Registers. Simple Verilog HDL programs.

Text Books/References

1. Floyd, Digital Fundamentals, McGraw Hill, Tenth Edition, 2011.
2. Morris Mano, Digital Circuits and Logic Design", PHI Publication, Fifth Edition, 2015.
3. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning,2001.
4. Donald D. Givone, Digital Principles and Design, McGraw Hill, 2002.
5. Charles H Roth Jr., Larry L. Kinney, Fundamentals of Logic Design, CengageLearning, 7th Edition.

ICS 121 Data Structures I [3-1-3-5]

Course Objectives

- Define and describe simple data structures like arrays, linked lists, trees and graphs
- Design and specify algorithms for searching and sorting, and those associated with the above data structures
- Analyse simple algorithms, like sorting and searching using mathematical tools, like formulation and solving of recurrences, asymptotic analysis and probabilistic analysis
- Analyse application problems and abstract them to formulate solutions involving data structures and algorithms

Course Outcomes

- Students learn to define operations of data structures like arrays, linked lists, trees and graphs
- Students learn to design and specify algorithms involving above types of data structures
- Students learn to analyze simple algorithms and solve recurrences,

asymptotic analysis and probabilistic analysis
- Students learn to analyze application problems and abstract them to formulate solutions involving data structures and algorithms

Syllabus

Introduction- Algorithm Analysis, Finding Complexity. Fundamental data structures - List- Sorted Lists, Double Linked Lists, Skip list
Stack & Queue application.- Celebrity problem, histogram rectangular area problem

Binary Trees – Insertion and Deletion of nodes, Tree Traversals, Polish Notations, Red Black Trees, B-Trees, Heaps, Priority Queues.

Optimal binary search tree, Application problems on Optimal binary search Tree

Sorting – Bubble, Selection, Insertion, Merge Sort, Quick Sort, Radix Sort, Heap sort. Searching.

Hashing- Application problems on hashing
Graphs- Shortest path algorithms, Minimum Spanning Trees, BFS, DFS.

Text Books/References

1. Clifford A Shaffer, Data Structures and Algorithm Analysis, Edition 3.2 (Java Version), 2011.
2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser. Data Structures And Algorithms In Java™ Sixth Edition, Wiley Publishers, 2014.
3. Mark Allen Weiss Data Structures And Algorithm Analysis In Java, Third Edition, 2012.
4. Robert L. Kruse, Data Structures And Program Design In C++, Pearson Education, Second Edition, 2006.
5. Ellis Horowitz, Fundamentals of Data Structures in C++, University Press, 2015.
6. Ajay Agarwal, Data Structure through C, A Complete Reference Guide, Cyber Tech Publications, 2005

ICS 122 Computer Organization [3-1-0-4]

Course Outcomes

- This course will introduce to students the fundamental concepts underlying modern computer organization and architecture.
- Students should be able to know the overall working of a computer.
- Students should be able to get a detailed understanding of the design principles involved in developing a computer.
- They should know the representation of data, how programs are represented, executed and how programs manipulate and operate on data.
- They should also be able to appreciate how the memory organization is done and how to organize memory for fasterexecution of programs.
- Students should also be able to appreciate the concepts in pipelining

Course objectives

- To understand the basics of computer hardware and how software interacts with computer hardware.
- To analyze and evaluate the performance of computers.
- Understand basics of Instruction Set Architecture (ISA) – RISC.
- To understand how computers represent and manipulate data.
- To understand how computer perform arithmetic operations, how they are optimized and made to run faster.
- To understand how the memory management takes place in a computer system.
- To understand what is pipelining, and the design concepts involved.
- Design a simple computer with hardware design including data format, instruction format, instruction set, addressing modes, bus structure, input/output, memory, Arithmetic/Logic unit, control unit, and data, instruction and address flow.

Syllabus

Computer abstraction and technology: Basic principles, hardware components, Measuring performance: evaluating, comparing and summarizing performance. Instructions: operations and operands of the computer hardware, representing instructions, making

decision, supporting procedures, character manipulation, styles of addressing, starting a program.

Computer Arithmetic: signed and unsigned numbers, addition and subtraction, logical operations, constructing an ALU, multiplication and division, floating point representation and arithmetic, Parallelism and computer arithmetic.

The processor: building a data path, simple and multi-cycle implementations, microprogramming, exceptions, Pipelining, pipeline Data path and Control, Hazards in pipelined processors

Memory hierarchy: caches, cache performance, virtual memory, common framework for memory hierarchies Input/output: I/O performance measures, types and characteristics of I/O devices, buses, interfaces in I/O devices, design of an I/O system, parallelism and I/O. Introduction to multicores and multiprocessors

Text Books/References

1. D. A. Pattersen and J. L. Hennesy, Computer Organisation and Design: The Hardware/ Software Interface, Fourth Edition, Morgan Kaufman, 2009.
2. V. P. Heuring and H. F. Jordan, Computer System Design and Architecture, Prentice Hall, 2003
3. Computer Architecture: A Quantitative Approach, Fifth Edition, Morgan Kaufman, 2011.
4. Carl Hamazher, ZvonkoVranesic and SafwatZaky, Computer Organization, Fifth Edition, McGraw Hill, 2002.

IEC 122 Principles of Communication [3-1-0-4]

Course Objectives

This course will enable students to

- Understand and analyse concepts of Analog Modulation schemes viz; AM, FM., Low pass sampling and Quantization as a random process.
- Understand and analyse concepts digitization of signals viz; sampling, quantizing and encoding.
- Evolve the concept of SNR in the presence of channel induced noise and study Demodulation of analog modulated signals.
- Evolve the concept of quantization noise for sampled and encoded signals and study the concepts of reconstruction from these samples at a receiver

Course outcomes

After studying this course the students will be able to

- Analyze and compute performance of AM and FM modulation in the presence of noise at the receiver.
- Analyze and compute performance of digital formatting processes with quantization noise.
- Multiplex digitally formatted signals at Transmitter and demultiplex the signals and reconstruct digitally formatted signals at the receiver.
- Design/Demonstrate the use of digital formatting in Multiplexers, Vocoders and Video transmission.

Syllabus

AMPLITUDE MODULATION: Introduction, Amplitude Modulation: Time & Frequency Domain description, Switching modulator, Envelop detector. DOUBLE SIDE BAND-SUPPRESSED CARRIER MODULATION: Time and Frequency Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing.

SINGLE SIDE–BAND AND VESTIGIAL SIDEBAND METHODS OF MODULATION: SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing,Theme Example: VSB Transmission of Analog and Digital Television.

ANGLE MODULATION: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Superheterodyne Receiver.

NOISE - Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth, NOISE IN ANALOG MODULATION: Introduction, Receiver Model, Noise in DSB-SC receivers. Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM

SAMPLING AND QUANTIZATION: Introduction, Why Digitize Analog Sources?, The Low-pass Sampling process Pulse Amplitude Modulation. Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves SAMPLING AND QUANTIZATION (Contd): The Quantization Random Process, Quantization Noise, Pulse–Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing; Delta Modulation, Application examples - (a) Video + MPEG and (b) Vocoders

Text Books/References

1. "Communication Systems", Simon Haykins & Moher, 5th Edition, John Willey, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.
2. Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University Press., 4th edition.
3. An Introduction to Analog and Digital Communication, Simon Haykins, John Wiley India Pvt. Ltd.,2008, ISBN 978–81–265–3653–5.
4. Principles of Communication Systems, H.Taub&D.L.Schilling, TMH,2011
5. Communication Systems, Harold P.E, Stern Samy and A.Mahmond, Pearson Edition, 2004.

IHS 121 PERSONALITY DEVELOPMENT [1-0-0-1]

Course Objectives

This course will enable students

- To understand the basic perspectives of human personality such as; Trait approach, Psychoanalytic approach, Biological basis, Humanistic/phenomenological approach, Behaviorist/learning, Cognitive approach , Interaction perspective, and Transpersonal perspective (Indian and Yoga Psychology).
- Learn to objectively assess and explain the behavior of other people, identify personality traits so as predict how a person will behave, and to help to function effectively.
- Have understanding how hiring decisions are taken based on personality characteristics that serve as requirements of a job
- Understanding the application of assessment of Type A & B personality on personal health & achievement
- Understand Personality disorders and its identification. Cognitive Behavior Therapy in the context of Psychotherapy for personality disorders.

Course outcomes

- Understand one's own personality and that of others, appreciate uniqueness of individuals, adapt to people and situations effectively, assess self and others using scientific tools of personality, cope with challenges in life with better understanding of human behavior science.

Syllabus

Personality: Meaning & Assessment. Psychoanalytic & Neo-Psychoanalytic Approach ; Behavioural Approach; Cognitive Approach; Social- Cognitive Approach; Humanistic Approach; The Traits Approach; Models of healthy personality: the notion of the mature person, the self-actualizing personality etc. Personality disorders; Psychotherapeutic techniques and Yoga & Meditation; Indian perspective on personality; Personality in Socio-cultural context.

Text Books/References

1. Schultz, D.P., & Schultz, S. E. (2005)(8th Edn.)Theories of Personality. Belmont: Thomson Wadsworth.
2. Lindzey, G., Campbell, J.B., & Hall, C.S.(2007)(4th Edn.). Theories of Personality. NewYork:Wiley & Sons
3. Ryckman, R.M. (2008)(9th Edn.).Theories of Personality.Belmont: Thomson Wadsworth.
4. Rao, K.R., & Paranjpe, A.C.(2016).Psychology in the Indian Tradition. NewDelhi:Springer.

5. Frankl, V.E.(1992). Man's Search for Meaning. Massachusetts:Beacon Press
6. Simanowitz, V., & Pearce, P. (2003). Personality Development. England: Open University Press.

SEMESTER III

IMA 211 Probability, Statistics, and Random Processes [3-1-0-4]

Course Objectives

- To expose the students to the modern theory of probability, concept of random variables and their expectations.
- To introduce various discrete and continuous distributions and concept of estimation theory, confidence interval.
- To illustrate the concept of hypothesis testing, tests for means and variances, Goodness of fit tests
- To introduce the concept of random processes, Markov chains, Brownian Motion

Course Outcomes:

- Define and apply the concepts of probability and conditional probability
- Define and illustrate discrete and continuous random variables, their probability mass functions and probability density functions
- Understand the concept and need of hypothesis testing
- Perform the tests for means and variances and Goodness of fit test
- Understand the concept of random processes, Markov chains, Brownian motions

Syllabus

Axiomatic construction of the theory of probability, independence, conditional probability, and basic formulae.

Random variables and distributions: Univariate, Bivariate and multivariate random variables, Cumulative and marginal distribution function, Conditional and multivariate distributions, Functions of random variables: Sum, product, ratio, change of variables.

Mathematical expectations, moments, moment generating function, characteristic functions;Discrete/continuous distributions and limit theorems: Binomial distribution, Geometric distribution, Poisson distribution, Normal distribution, Exponential distribution, Gamma distribution, Beta distribution, Central limit theorem, Tchebeyche's inequality, Law of large numbers

Estimation Theory: Bias of estimates, Confidence intervals, Minimum variance unbiased estimation, Bayes' estimators, Moment estimators, Maximum likelihood estimators, Chi-square distribution, Confidence intervals for parameters of normal distribution

Hypothesis testing: Tests for means and variances, hypothesis testing and confidence intervals, Bayes' decision rules, Power of tests, Goodness-of-fit tests, Kolmogorov-Smirnov Goodness-of-fit test

Definition and classification of random processes, discrete-time Markov chains, Poisson process, continuous-time Markov chains, stationary processes, Gaussian process, Brownian motion

Text Books/ References

1. S. Ross, Introduction to Probability and Statistics for and Engineers and Scientists, Third Edition, Elsevier, 2004.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2000.
3. S. M. Ross, Introductory Statistics, Second Edition, Academic Press, 2009.
4. J. Medhi, Stochastic Processes, Third Edition, New Age International, 2009.
5. V.K.Rohati and A.K. Saleh, An introduction to Probability and Statistics, Third Edition. Wiley Student Edition, 2006.
6. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, Oxford University Press, 2001.
7. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Third Edition.,Wiley, 1968.
8. S.M. Ross, Stochastic Processes, Second Edition. Wiley, 1996.

9. C. M. Grinstead and J. L. Snell, Introduction to Probability, Second Edition, Universities Press India, 2009.
10. S.Ross, A First Course in Probability, 10th Edition, Pearson Education, Delhi, 2018

IEC 211 Control Systems [3-1-0-4]

Course Objectives:

This course will enable students to:

- Understand the basic features, configurations and application of control systems.
- Understand various terminologies and definitions for the control systems.
- Learn how to find a mathematical model of electrical, mechanical and electro- mechanical systems.
- Know how to find time response from the transfer function.
- Find the transfer function via Mason s' rule.
- Analyze the stability of a system from the transfer function.

Course Outcomes:

- Develop the mathematical model of mechanical and electrical systems.
- Develop transfer function for a given control system using block diagram reduction techniques and signal flow graph method.
- Determine the time domain specification s for first an d second order systems.
- Deter mine the stability of a system in the time domain using Routh-Hurwitz criterion and Root-locus technique.
- Determine the s stability of a system in the frequency domain u sing Nyquist and bode plots

Syllabus

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems –Mechanical Systems, Electrical Systems, Electromechanical systems, Analogous Systems.

Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants.

Introduction to PI, PD and PID Controllers (excluding design). Stability analysis: Concepts of stability, Necessary conditions for Stability, Routhstability criterion, Relative stability analysis: more on the Routh stability criterion.

Introduction to Root-Locus Techniques, The root locus concepts, Construction of rootloci.

Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function.

Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded)

Introduction to lead, lag and lead- lag compensating networks (excluding design). Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Solution of state equations.

Text Books/ References

1. "Modern Control Engineering," K.Ogata, Pearson Education Asia/ PHI,4 Edition, 2002. ISBN 978 - 81 - 203 - 4010 - 7.
2. "Automatic Control Systems", Benjamin C. Kuo, JohnWiley India Pvt. Ltd.,8 Edition, 2008.
3. "Feedback and Control System," Joseph J Distefano III et al., Schaum'sOutlines, TMH, 2 nd Edition 2007.

IEC 212 Analog Integrated Circuits [3-0-3-4]

Course Objectives:

- Explain various BJT parameters, connections and configurations.
- Design and demonstrate transistor amplifiers.
- Explain various types of FET biasing, and demonstrate the use of FET amplifiers.
- Construct frequency response of FET amplifiers at various frequencies.
- Analyze Power amplifier circuits in different modes of operation.
- Construct Feedback and Oscillator circuits using FET.

Course Outcomes:

- Understand the characteristics of BJTs and FETs.
- Design and analyze BJT and FET amplifier circuits.
- Design sinusoidal and non-sinusoidal oscillators.
- Understand the functioning of linear ICs.
- Design of Linear IC based circuits.

Syllabus

Biasing in BJT amplifier circuits: fixed bias, Voltage-divider bias, Biasing using a collector to base feedback resistor.

Small signal operation and Models: Collector current and transconductance, Base current and input resistance, Emitter current and input resistance, voltage gain, Separating the signal and the DC quantities, The hybrid Π model.

MOSFETs: Biasing in MOS amplifier circuits: Fixing Vgs , Fixing Vg , Drain to Gate feedback resistor. Small signal operation and modeling: The DC bias point, signal current in drain, voltage gain, small signal equivalent circuit models, transconductance.

MOSFET Amplifier configuration: Basic configurations, characterizing amplifiers, CS amplifier with and without source resistance Rs, Source follower.

MOSFET internal capacitances and High frequency model: The gate capacitive effect, Junction capacitances, High frequency model.

Frequency response of the Cs amplifier: The three frequency bands, high frequency response, Low frequency response.

Oscillators: FET based Phase shift oscillator, LC and Crystal Oscillators

Feedback Amplifier: General feedback structure, Properties of negative feedback, The Four Basic Feedback Topologies, The series-shunt, series-series, shunt-shunt and shunt-series amplifiers (Qualitative Analysis).

Output Stages and Power Amplifiers: Introduction, Classification of output stages,, Class A output stage, Class B output stage: Transfer Characteristics, Power Dissipation, Power Conversion efficiency, Class AB output stage, Class C tuned Amplifier.

Op-Amp with Negative Feedback and general applications : Inverting and Non inverting Amplifiers – Closed Loop voltage gain, Input impedance, Output impedance, Bandwidth with feedback. DC and AC Amplifiers, Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Comparators, Zero Crossing Detector, Schmitt trigger.

Op-Amp Circuits: DAC - Weighted resistor and R-2R ladder, ADC- Successive approximation type, Small Signal half wave rectifier, Active Filters, First and second order low-pass and high- pass Butterworth filters, Band-pass filters, Band reject filters

555 Timer and its applications: Monostable and astable Multivibrators.

Lab Practice

Design and setup the Common Source JFET/MOSFET amplifier and plot the frequency response.

Design and set up the BJT common emitter voltage amplifier with and without feedback and

determine the gain- bandwidth product, input and output impedances

Design Adder, Integrator and Differentiator circuits using Op-Amp

Test a comparator circuit and design a Schmitt trigger for the given UTP and LTP values and obtain the hysteresis

Design Monostable and a stable Multivibrator using 555 Timer.

Text Books/ References

1. Microelectronic Circuits, Theory and Applications, Adel S Sedra, Kenneth C Smith, 6 th Edition, Oxford, 2015.ISBN:978-0-19-808913-1
2. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, 4 th Edition. Pearson Education, 2000. ISBN: 8120320581
3. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, 11 th Edition, Pearson Education, 2013, ISBN: 978-93-325-4260-0.
4. Fundamentals of Microelectronics, BehzadRazavi, 2 nd Edition, John Weily, 2015, ISBN 978-81-265-7135-2.
5. J.Millman&C.C.Halkias—Integrated Electronics, 2 nd edition, 2010, TMH. ISBN 0-07-462245-5

IEC 213 Microprocessors and Microcontrollers [3-0-3-4]

Course Objectives:

- Familiarize the importance and applications of microprocessors and microcontrollers
- Expose architecture of 8086 processor and 8051 microcontroller
- Impart design and coding knowledge on 8086 and 8051 family.
- Understand the interrupt system of 8086 and 8051 and the use of interrupts
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051.
- Interface 8086 and 8051 to external memory and I/O devices using its I/O ports.

Course Outcomes:

- Design and develop assembly language/C code to solve problems using 8086/8051
- Gain the knowledge for interfacing various devices to 8086 family and 8051
- Demonstrate design of interrupt routines for interfacing devices
- Know functioning of hardware devices and interfacing them to x86 and 8051

Syllabus

8086 architecture, addressing modes, machine language instruction formats, instruction set, programming using assembly language and C, memory interfacing, interrupts, interrupt programming, macros, 8086 bus configuration and timings, physical memory organization, I/O addressing capability, minimum mode, maximum mode operations, basic I/O interfacing, peripherals and their interfacing with 8086.

8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing. 8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Assembly language program examples.

8051 Stack, I/O Port Interfacing and Programming: 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine

8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

8051 Interrupts and Interfacing Applications: 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt.

Interfacing 8051 to ADC-0804, DAC, and Stepper motor.

Lab Practice

Data Transfer: Block Move, Exchange, Sorting, Finding largest element in an array.Arithmetic Instructions: Addition, subtraction, multiplication and division, square, Cube (16 bits Arithmetic operations – bit addressable). Counters.

Boolean & Logical Instructions (Bit manipulations). conditional CALL and RETURN. Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal -HEX. Programs to generate delay, Programs using serial port and on-Chip timer/counter.

Interface a simple toggle switch to 8051 and write an ALP to generate an interrupt which switches on an LED (i) continuously as long as switch is on and (ii) only once for a small time when the switch is turned on. Write a program to (i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal. Write ALPs to generate waveforms using ADC interface. Write ALP to interface a Stepper Motor to 8051 to rotate the motor.

Text Books/ References

1. Douglas Hall, SSSP Rao "Microprocessor and Interfacing", 3rd edition, Tata Mc Graw Hill, 2012.
2. Kenneth J Ayala, "The 8086 Microprocessor programming and Interfacing the PC" Cengage Learning, 2011.
3. Lyla B das, "Microprocessors and Microcontrollers", Pearson education India, 2nd edition, 2014
4. The 8051 Microcontroller and Embedded Systems using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
5. The 8051 Microcontroller, Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.
6. The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.

IEC 214 Signals and Systems [3-1-0-4]

Course Objectives:

- Understand the mathematical description of continuous and discrete time signals and systems.
- Analyze the signals in time domain using convolution sum and Integral.
- Classify signals into different categories based on their properties.
- Analyze Linear Time Invariant (LTI) systems in time and transform domains.

Course Outcomes:

- Analyze the different types of signals and systems.
- Determine the linearity, causality, time-invariance and stability properties of continuous and discrete time systems.
- Represent continuous and discrete systems in time and frequency domain using different transforms
- Test whether the system is stable.

Syllabus

Introduction and Classification of signals: Definition of signal and systems, communication and control system as examples Classification of signals. Basic Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration, time scaling, time shift and time reversal. Elementary signals/Functions: Exponential, sinusoidal, step, impulse and ramp functions.

Expression of triangular, rectangular and other waveforms in terms of elementary signals.

System Classification and properties: Linear-nonlinear, Time variant-invariant, causal-noncausal, static-dynamic, stable-unstable, invertible. Time domain representation of LTI System: Impulse response, convolution sum, convolution integral. Computation of convolution sum and convolution integral using graphical

method for unit step and unit step, unit step and exponential, exponential and exponential, unit step and rectangular, and rectangular and rectangular.

LTI system Properties in terms of impulse response: System interconnection, Memory-less, Causal, Stable, Invertible and Deconvolution, and step response.

Fourier Representation of Periodic Signals: CTF Sproperties and basic problems. Fourier Representation of aperiodic Signals: Introduction to Fourier Transform & DTFT, Definition and basic problems.

Properties of Fourier Transform: Linearity, Time shift, Frequency shift, Scaling, Differentiation and Integration, Convolution and Modulation, Parseval's theorem and problems on properties of Fourier Transform.

The Z-Transforms: Z transform, properties of the region of convergence, properties of the

Z-transform, Inverse Z-transform, Causality and stability, Transform analysis of LTI systems.

Text Books/ References

1. Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.
2. Michael Roberts, "Fundamentals of Signals & Systems", 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
3. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
4. H.P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2006.
5. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2005.

IEC 215 Power Electronics and Instrumentation [3-0-0-3]

Course Objectives:

- Study and analysis of thyristor circuits with different triggering conditions.
- Learn the applications of power devices in controlled rectifiers, converters and inverters.
- Understand types of instrument errors.
- Develop circuits for multirange Ammeters and Voltmeters.
- Describe principle of operation of digital measuring instruments and Bridges.
- Understand the operation of Transducers, Instrumentation amplifiers and PLCs.

Course Outcomes:

- Build and test circuits using power electronic devices
- Analyze and design controlled rectifier, DC to DC converters, DC to AC inverters and SMPS
- Define instrument errors
- Develop circuits for multirange Ammeters, Voltmeters and Bridges to measure passive component values and frequency.
- Describe the principle of operation of Digital instruments and PLCs
- Use Instrumentation amplifier for measuring physical parameters

Syllabus

Introduction: History, Power Electronic Systems, Power Electronic Converters and Applications. Thyristors: Static Anode-Cathode characteristics and Gate characteristics of SCR, Turn-ON methods, Turn-OFF mechanisms, Turn-OFF Methods: Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit ,Unijunction Transistor: Basic operation and UJT Firing Circuit.

Phase Controlled Converter: Control techniques, Single phase half wave and full wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode. Choppers: Chopper Classification, Basic Chopper operation: step-down, step-up and step-up/down choppers.

Inverters: Classification, Single phase Half bridge and full bridge inverters with R and RL load.

Switched Mode Power Supplies: Isolated Flyback Converter, Isolated Forward Converter. Principles of Measurement: Static Characteristics, Measurement, Types of Static Error. Multirange

Ammeters, Multirange voltmeter. Digital Voltmeter: Ramp Technique, Dual slope integrating Type DVM, Direct Compensation type and Successive Approximations type DVM. Digital Multimeter: Digital Frequency Meter and Digital Measurement of Time, Function Generator. Bridges: Measurement of resistance: Wheatstone's Bridge, AC Bridges-Capacitance and Inductance Comparison bridge, Wien's bridge.

Transducers: Introduction, Electrical Transducer, Resistive Transducer, Resistive position Transducer, Resistance Wire Strain Gauges, Resistance Thermometer, Thermistor, LVDT. Instrumentation Amplifier using Transducer Bridge, Temperature indicators using Thermometer, Analog Weight Scale.

Programmable Logic Controller: Structure, Operation, Relays and Registers.

Text Books/ References

1. Mohammad H Rashid, Power Electronics, Circuits, Devices and Applications, 3rd /4th Edition, Pearson Education Inc, 2014, ISBN: 978-93-325-1844-5.
2. L. Umanand, Power Electronics, Essentials and Applications, John Wiley India Pvt. Ltd, 2009.
3. David A. Bell, "Electronic Instrumentation & Measurements", Oxford University Press PHI 2nd Edition, 2006, ISBN 81-203-2360-2.
4. A. D. Helfrick and W.D. Cooper, "Modern Electronic Instrumentation and Measuring Techniques", Pearson, 1st Edition, 2015, ISBN: 9789332556065.
5. M.D Singh and K B Khanchandani, Power Electronics, 2nd Edition, Tata Mc-Graw Hill, 2009, ISBN: 007058389
6. H. S. Kalsi, "Electronic Instrumentation", McGraw Hill, 3rd Edition , 2012, ISBN: 9780070702066.

ICS 215 Data Structures II [1-0-3-2]

Course Objectives

- Teach programming with emphasis on problem solving and introduce Data structures.
- Provide the Foundations of the practical implementation and usage of Algorithms and Data Structures.

Course Outcomes:

- Design correct programs to solve problems.
- Choose efficient data structures and apply them to solve problems.

Syllabus

Problems on Geometric algorithms but not limited to: Klee's Algorithm, Manhattan distance problems, Collinear checking, Identifying Integral points inside a Triangle, Circumcenter of a Triangle, Triangular Matchstick Number, area of Circumcircle of an Equilateral Triangle, Number of rectangles in N*M grid, Area of two overlapping rectangles, Number of unique rectangles formed using N unit squares, Circle and Lattice Points, Pizza cut problem.

Algorithms on Bit Manipulation but not limited to: Letter manipulation problems, k-th bit Manipulation problems, Kernighan's Algorithm to count set bits in an integer.

Discussion on Numerical algorithms but not limited to: Gauss-Jordan Elimination, Matrix Manipulation problems.

Text Books/References

1. Cormen, Thomas H., et al. *Introduction to algorithms*. MIT press, 2009.
2. Aho, Albred V., J. E. Hopcroft, and J. D. Ullman. "*Data structures and algorithms* (1983).
3. Drozdek, Adam. *Data Structures and algorithms in C++*. Cengage Learning, 2012.
4. Allen, Weiss Mark. *Data structures and algorithm analysis in C++*. Pearson Education India, 2007.
5. Kleinberg, Jon, and Eva Tardos. *Algorithm design*. Pearson Education India, 2006.
6. Skiena, Steven S. *The algorithm design manual*. Springer International Publishing, 2020.
7. Knuth, Donald Ervin. *The art of computer programming*. Vol. 3. Pearson Education, 1997.
8. Nomura, Seiichi. "C Programming and Numerical Analysis: An Introduction."

Synthesis Lectures on Mechanical Engineering 2.2 (2018): 1-198.
9. Dasgupta, Sanjoy, C. H. Papadimitriou, and U. V. Vazirani. "*Algorithms*; 2006."

10. Trefethen, Lloyd N., and David Bau III. Numerical linear algebra. Vol. 50. Siam, 1997.

SEMESTER IV

IEC 221 Digital Design with Hardware Description Languages [3-0-3-4]

Course Objectives:
This course will enable students to

- Design digital systems in a larger system design context.
- Understand the concepts of Verilog HDL
- Implementation of digital systems using Verilog HDL

Course Outcomes:
After studying this course, students will be able to:

- Construct the combinational circuits, using discrete gates
- Design a sequential circuit
- Describe Verilog model for combinational and sequential circuits and test pattern generation.

Syllabus:
Revision of basic Digital systems: Combinational Circuits, Sequential Circuits, Timing, set-up and hold time, Power Dissipation, Mealy and Moore Machines, Equivalent States and Reduction of State Tables

Current state of the field: SoC, IP Design, Design Methodology, System modeling, Hardware Software Co-design, Application Domains.

Digital System Design: Top-Down approach to design, Data-path, Control-path, Pipelining, Resource sharing

Introduction to HDL: (VHDL/Verilog): (Use either VHDL or Verilog for RTL).

Computer Aided Design, Hardware Description Languages, Verilog description of combinational circuits, Verilog modules and assignments, Modeling flip flops using an Always Block, Delays in Verilog, Compilation, Simulation and Synthesis of Verilog code, Verilog datatypes and operators, Verilog models for multiplexers, Modeling Registers using Always statements, Behavioral and Structural Verilog.

Introduction to Programmable Logic Devices: Overview of Programmable Logic Devices, Simple Programmable Logic Devices (SPLDs), Programmable Logic Arrays (PLAs), Programmable Logic Devices (PLDs), Complex Programmable Logic Devices (CPLDs), Field Programmable Gate Arrays (FPGAs), Design flow for FPGAs

Laboratory:
Implementation of combinational and sequential designs using Verilog HDL

Text Book/ References

1. Charles Roth, Lizy K John, Byeong Kil Lee, Digital System Design Using Verilog
2. Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design
3. Peter J. Ashenden, - Digital Design: An Embedded Systems Approach Using VERILOG, Elesvier, 2010.

IEC 222 Digital Communication [3-0-3-4]

Course Objectives
- Understand the mathematical representation of signal, symbol, and noise.
- Understand the concept of signal processing of digital data and signal conversion to symbols at the transmitter and receiver.
- Compute performance metrics and parameters for symbol processing and recovery in ideal and corrupted channel conditions.
- Compute performance parameters and mitigate channel induced impediments in corrupted channel conditions.

Course Outcomes:
- Associate and apply the concepts of Bandpass sampling to well specified signals and channels.
- Analyze and compute performance parameters and transfer rates for low pass and bandpass symbol under ideal and corrupted non band limited channels.

- Test and validate symbol processing and performance parameters at the receiver under ideal and corrupted band-limited channels.
- Demonstrate that bandpass signals subjected to corruption and distortion in a band-limited channel can be processed at the receiver to meet specified performance criteria.

Syllabus

Bandpass Signal to Equivalent Low pass: Hilbert Transform, Pre-envelopes, Complex

envelopes, Canonical representation of bandpass signals, Complex low pass representation of bandpass systems, Complex representation of band pass signals and systems.

Unipolar, Polar, Bipolar (AMI) and Manchester code and their power spectral densities.

Overview of HDB3, B3ZS, B6ZS.

Signaling over AWGN Channels- Introduction, Geometric representation of signals, Gram-Schmidt Orthogonalization procedure, Conversion of the continuous AWGN channel into a vector channel, Optimum receivers using coherent detection: ML Decoding, Correlation receiver, matched filter receiver.

Digital Modulation Techniques: Phase shift Keying techniques using coherent detection:

generation, detection and error probabilities of BPSK and QPSK, M–ary PSK, M–ary QAM.

Frequency shift keying techniques using Coherent detection: BFSK generation, detection and error probability.

Non coherent orthogonal modulation techniques: BFSK, DPSK Symbol representation, Block diagrams treatment of Transmitter and Receiver, Probability of error.

Communication through Band Limited Channels: Digital Transmission through Band limited channels: Digital PAM Transmission through Band limited Channels, Signal design for Band limited Channels: Design of band limited signals for zero ISI–The Nyquist Criterion, Design of band limited signals with controlled ISI-Partial Response signals, Probability of error for detection of Digital PAM: Probability of error for detection of Digital PAM with Zero ISI, Symbol–by–Symbol detection of data with controlled ISI.

Principles of Spread Spectrum: Spread Spectrum Communication Systems: Model of a Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Systems, Effect of De-spreading on a narrowband Interference, Probability of error (statement only), Some applications of DS Spread Spectrum Signals, Generation of PN Sequences, Frequency Hopped Spread Spectrum, CDMA based on IS-95.

Text Books/ References

1. Simon Haykin, “Digital Communication Systems”, John Wiley & sons, First Edition, 2014, ISBN 978-0-471-64735-5.
2. John G Proakis and MasoudSalehi, “Fundamentals of Communication Systems”, 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.
3. B. P. Lathi and Zhi Ding, “Modern Digital and Analog communication Systems”, Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.
4. Ian A Glover and Peter M Grant, “Digital Communications”, Pearson Education, Third Edition, 2010,ISBN 978-0-273-71830-7.
5. Bernard Sklar and Ray, "Digital Communications - Fundamentals and Applications", Pearson Education, Third Edition, 2014, ISBN: 978-81-317-2092-9.

IEC 223 Electromagnetic Theory [3-1-0-4]

Course Objectives

- Study the different coordinate systems, Physical significance of Divergence, Curl and Gradient.
- Understand the applications of Coulomb‘s law and Gauss law to different charge distributions and the applications of Laplace‘s and Poisson‘s

Equations to solve real time problems on capacitance of different charge distributions.

- Understand the physical significance of Biot-Savart's, Amperes's Law and Stoke' theorem for different current distributions.
- Infer the effects of magnetic forces, materials and inductance.
- Know the physical interpretation of Maxwell' equations and applications for Plane waves for their behavior in different media.
- Acquire knowledge of Poynting theorem and its application of power flow.

Course Outcomes:

- Evaluate problems on electrostatic force, electric field due to point, linear, volume charges by applying conventional methods and charge in a volume.
- Apply Gauss law to evaluate Electric fields due to different charge distributions and Volume Charge distribution by using Divergence Theorem.
- Determine potential and energy with respect to point charge and capacitance using Laplace equation and Apply Biot-Savart's and Ampere's laws for evaluating Magnetic field for different current configurations
- Calculate magnetic force, potential energy and Magnetization with respect to magnetic materials and voltage induced in electric circuits.
- Apply Maxwell's equations for time varying fields, EM waves in free space and conductors and Evaluate power associated with EM waves using Poynting theorem

Syllabus

Revision of Vector Calculus – Coulomb's Law, Electric Field Intensity and Flux density: Experimental law of Coulomb, Electric field intensity, Field due to continuous volume charge distribution, Field of a line charge, Field due to Sheet of charge, Electric flux density, Numerical Problems.

Gauss's law and Divergence: Gauss 'law, Application of Gauss' law to point charge, line charge, Surface charge and volume charge, Point (differential) form of Gauss law, Divergence. Maxwell's First equation (Electrostatics), Vector Operator ∇ and divergence theorem, Numerical Problems.

Energy, Potential and Conductors: Energy expended or work done in moving a point charge in an electric field, The line integral, Definition of potential difference and potential, The potential

field of point charge, Potential gradient, Numerical Problems. Current and Current density, Continuity of current.

Poisson's and Laplace's Equations: Derivation of Poisson's and Laplace's Equations, Uniqueness theorem, Examples of the solution of Laplace's equation, Numerical problems on Laplace equation Steady Magnetic Field: Biot-Savart Law, Ampere's circuital law, Curl, Stokes' theorem, Magnetic flux and magnetic flux density, Basic concepts Scalar and Vector Magnetic Potentials, Numerical problems.

Magnetic Forces: Force on a moving charge, differential current elements, Force between differential current elements, Numerical problems. Magnetic Materials: Magnetization and permeability, Magnetic boundary conditions, The magnetic circuit, Potential energy and forces on magnetic materials, Inductance and mutual reactance, Numerical problems.

Faraday' law of Electromagnetic Induction – Integral form and Point form, Numerical problems.

Maxwell's equations Continuity equation, Inconsistency of Ampere's law with continuity equation, displacement current, Conduction current, Derivation of Maxwell's equations in point form, and integral form, Maxwell's equations for different media, Numerical problems.

Uniform Plane Wave: Plane wave, Uniform plane wave, Derivation of plane wave equations from

Maxwell's equations, Solution of wave equation for perfect dielectric, Relation between E and H, Wave propagation in free space, Solution of wave equation for sinusoidal excitation, wave

propagation in any conducting media (γ, α, β, η) and good conductors, Skin effect or Depth of penetration, Poynting's theorem and wave power, Numerical problems.

Text Books/ References

1. W.H. Hayt and J.A. Buck, Engineering Electromagnetics, 8th Edition, Tata McGraw Hill, 2014, ISBN-978-93-392-0327-6.
2. Elements of Electromagnetics Matthew N.O., Sadiku, Oxford university press, 4th edition
3. Electromagnetic Waves and Radiating systems, E. C. Jordan and K.G. Balman, PHI, 2nd Edition
4. Electromagnetics Joseph Edminister, Schaum Outline Series, McGraw Hill.

ICS 224 Computer networks [3-0-3-4]

Course Objectives

- The students should understand the layers of networking devices.
- They should be familiar with a few networking protocols.
- They should study the different types of networks and topologies of networks.

Course Outcomes:

- To distinguish the importance of different networking components.
- To understand the functionalities of each networking layers and standards.
- To write simple networking based programs at real and simulator level.

Syllabus

Evolution of computer networks: Network Architecture-OSI, TCP/IP models.

Physical and Data link layer: Encoding, Framing, Error detection, HDLC, PPP, sliding window protocols, medium access control, Token Ring, Wireless LAN, Packet Switching.

Network Layer: Internet addressing, IP, ARP, ICMP, CIDR, Routing algorithms (RIP, OSPF, BGP).

Transport Layer: UDP, TCP, flow control, congestion control Introduction to quality of service.

Application Layer: DNS, Web, HTTP, email, authentication, encryption.

Lab Practice

Unix network measurement and analysis tools, NS3 Socket interface and programming, RPC, RMI, Assignments using Network Simulators.

Text Books/ References

1. L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Elsevier, 2011.
2. A. S.Tanenbaum and D.J. Wetherall, Computer Networks, Fifth Edition, Pearson, 2011.
3. R. Stevens, UNIX Network Programming, Volume 1: Networking APIs: Sockets and XTI, Second Edition, PrenticeHall,1998.
4. S. S. Panwar, S. Mao, J. Ryoo, and Y. Li, TCP/IP Essentials: A Lab-based Approach, Cambridge Press, 2004.
5. J. F. Kurose and K. W. Ross, Computer Networking: A Top Down Approach, Seventh Edition, Pearson India, 2017.
6. D. E. Comer, Internetworking with TCP/IP Vol. 1, Sixth Edition, Prentice Hall of India, 2006.
7. B. Forouzan, Data Communications and Networking, Fifth Edition, Tata Mcgraw Hill, 2012.
8. Introduction to Network Simulator NS2, Second Edition, 2011

IMA 221 Differential Equations and transforms [3-1-0-4]

Course Objectives

- Find the Fourier series representation of a function of one variable
- Introduce the Fourier series and its application to the solution of partial differential equations
- Introduce the concepts of Laplace and Fourier transforms.

- Identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution of first order and selected higher order ordinary differential equations.
- Introduce students to partial differential equations
- Introduce students to how to solve linear Partial Differential with different methods.

Course Outcomes:

- Analyse and solve engineering problems using Fourier series.
- Find the Laplace and Fourier transforms of functions of one variable.
- Solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases. Find particular solutions when given initial or boundary conditions.
- Will be able to find solution of higher-order linear differential equations
- Classify PDEs, apply analytical methods, and physically interpret the solutions.

Syllabus

Fourier Series : Dirichlet's conditions – General Fourier series – Odd and even functions – Half range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis. Convergence of FS, differentiation and integration of Fourier series.

Fourier Transform Fourier Integral Theorem – Fourier transform pair - Sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

Ordinary Differential Equations: Method of variation of parameters – Method of undetermined coefficients – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

Partial Differential Equations Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's linear equation – Integral surface passing through a given curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous

Fourier Series Solutions Of Partial Differential Equations: Method of separation of variables – Solutions of one dimensional wave equation and one dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

Text Books/ References

1. C. Edwards and D. Penney, Elementary Differential Equations with Boundary Value Problems, 6th edition, Pearson, 2003
2. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations, 7th Ed., John Wiely& Sons, 2002.

IHS 221 Fundamentals of Economics [1-0-0-1]

Course Objectives

- To familiarize the participants concepts and techniques in Economics
- To make the participants appreciate the applications of core concepts in economics for managerial decision making
- To sensitize the participants how economic environment affects Organizations

Course Outcome

- It will help the students to analyse the demand and supply conditions and assess the positions of a company.
- It will help to design competition strategies, including costing, pricing, product differentiation and market environment according to the natures of products and structures of market

Syllabus

Introduction to Fundamentals of Economics

Micro & Macro Economics, Managerial Economics – Definition – Nature & Scope, Fundamental concepts in Managerial economics for decision making: Incremental Principle, Opportunity Cost, Discounting Principle, Time Concept, Equi-Marginal Principle – Illustrations, Decision Making – Process and Conditions – Difference between Risk & Uncertainty.

Demand Analysis and Forecasting

Meaning of Demand – Types of Demand – Law of Demand & its Exceptions, Elasticity of Demand – Price Elasticity, Income Elasticity, Cross Elasticity, Promotion Elasticity, Applications of the concepts of Elasticity, Demand Forecasting – Process – Statistical & Non-Statistical Techniques, Utility Analysis & Consumer Behaviour – Equilibrium of the consumer using Cardinal & Ordinal Utility (Indifference Curve) Theories.

Supply & Production

Theory of Production – Meaning of Production function, Production function with one variable input – Law of Variable Proportions – Returns to Scale, Production function with two variable inputs – Iso-quants – Producers' Equilibrium,Economies of Scale – Types – Economies of Scope, Theory of Costs – Classification of Costs - Short Run & Long Run Cost Curves, Revenue Curves.

Market Structure

Market – Meaning & Elements, Classification of Markets – Markets based on Competition, Theory of Firm – Profit Maximization Rules, Price & Output Determination under Perfect Competition, Price & Output Determination under Monopoly – Monopoly Price Discrimination, Price & Output Determination under Monopolistic Competition, Price & Output Determination under Oligopoly – Kinked Demand curve model only.

Macro Economic Concepts

National Income Concepts – Measurement of National Income, An overview of Financial System in India, An overview of Fiscal & Monetary Policies in India, Balance of Payments: Causes of Disequilibrium & Remedies, Inflation in India – Causes & Remedies. Free Market Economy & Need for Government Intervention – An appraisal of Economic Reforms in India

Text Books/ References

1. Dwivedi D.N, Managerial Economics, Vikas Publications (ISBN 8125910042)
2. P.L. Mehta, Managerial Economics Analysis, Problems and Cases – Sultan Chand & Sons (ISBN 81-7014-386-1)
3. K.K. Dewett, Modern Economic Theory: Micro & Macro Analysis – Orient Book Distributors, New Delhi.
4. V.L. Mote, Managerial Economics – Tata McGraw Hill, New Delhi
5. Gaurav Dutt & Aswani Mahajan, Dutt &Sundaram's Indian Economy – Sultan Chand & Sons.

IHS 222 Principles of Management [1-0-0-1]

Course Objectives

- To introduce Profession of Management and help the students gain understanding of the functions and responsibilities of the manager.
- To provide participants tools and techniques to be used in the performance of the managerial job, and enable them to analyze and understand the environment of the organisation

Course Outcome

- It will help the students to gain understanding of the functions and responsibilities of managers
- It will provide them tools and techniques to be used in the performance of managerial job

Syllabus

Management - Meaning, Definition and Nature; Evolution of Management – Management Thoughts - Early - Modern - Post modern; Contributions of F.W. Taylor - Henry Fayol – Hawthorne Studies-Behavioural School of Management Approach. Levels of Management,

Skills required for a manager, Managerial roles. Management Lessons from Indian Philosophy – Vision, Effectiveness, Efficiency and Teamwork.

Functions of Management: POSDCORB; Characteristics of Management;

Planning: -Meaning – nature – importance -Levels of planning. Objectives – setting objectives – Policies – Planning premises, Types of plans - Process of planning - Decision Making; MBO; Principles in Planning

Organising: - Nature-Purpose-Principles- Organisational Structure and types - Departmentation - Centralization vs. Decentralization - Span of control- Delegation of Authority – Principles in Organising – Line Vs Staff Authority – Networking and Virtual Organizations Staffing: - Meaning, Principles in Staffing, Staffing Functions

Directing: - Leadership – Leadership Traits – Leadership Styles – Principles in Directing – Emerging Trends in Management; Management of Creativity & Innovation – Creative Process – Managing E-Business World – Challenges – Management in Globalized Era – Organizational Social Responsibility Control:- System and process of Controlling - Requirements for effective control - The Budget as Control Technique - Information Technology in Controlling – Control Techniques- Control and planning- Types of Control– Reporting - Co-ordination; Principles in Control and Co ordination

Textbooks/References

1. K.Aswathapa, " Essential of Business Administration", Himalaya Publishing House
2. Harold Koontz & Heinz Weihrich, "Essentials of Management", Tata McGraw-Hill,1998
3. JAF Stomer, Freeman R. E and Daniel R Gilbert, "Management", Pearson Education, Sixth Edition, 2004.
4. Stephen P. Robbins and Mary Coulter, "Management"', Prentice Hall of India, 8th edition.
5. Tripathy PC and Reddy PN, "Principles of Management", Tata McGraw-Hill, 1999.
6. Y.K. Bhusan, "Fundamentals of Business Organisation & Management"; Sultan Chand & Co., New Delhi

ICS 225 Data Structure III [1-0-3-2]

Course Objectives

- Ensure that the student evolves into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.
- Expose the student to the algorithm analysis techniques.

Course Outcomes

- Analyze the efficiency of programs based on Complexity.
- Understand the necessary mathematical abstraction to solve problems.

Syllabus

Algorithms on Graph connectivity but not limited to: Tarjan's and Kosaraju's strongly connected components algorithms, Detect cycles in an undirected graph, Degree of vertices in a Graph, Path identification between vertices in Undirected graph.

Discussions on Randomized algorithms but not limited to: Reservoir Sampling, Birthday Paradox, Load Balancing problem, Karger's algorithm for Minimum Cut, Freivald's Algorithm to check the product of a matrix, Monte Carlo estimation.

Branch and Bound Algorithms: Knapsack problem, Travelling salesman problem.

Threaded Binary Tree, Splay trees, Foldable binary trees, Additional problems on BST, Binomial heap, Fibonacci heap, Topological sorting, self-organizing tree, segment tree, Binary indexed tree, suffix array and suffix tree, pattern searching , Tribonacci word.

Text Books/References:

1. Cormen, Thomas H., et al. Introduction to algorithms. MIT press, 2009.
2. Aho, Albred V., J. E. Hopcroft, and J. D. Ullman. "Data structures and algorithms (1983).

3. Drozdek, Adam. Data Structures and algorithms in C++. Cengage Learning, 2012.
4. Allen, Weiss Mark. Data structures and algorithm analysis in C++. Pearson Education India, 2007.
5. Kleinberg, Jon, and Eva Tardos. Algorithm design. Pearson Education India, 2006.
6. Skiena, Steven S. The algorithm design manual. Springer International Publishing, 2020.
7. Knuth, Donald Ervin. The art of computer programming. Vol. 3. Pearson Education, 1997.
8. Nomura, Seiichi. "C Programming and Numerical Analysis: An Introduction." Synthesis Lectures on Mechanical Engineering 2.2 (2018): 1-198.
9. Dasgupta, Sanjoy, C. H. Papadimitriou, and U. V. Vazirani. "Algorithms; 2006."
10. Trefethen, Lloyd N., and David Bau III. Numerical linear algebra. Vol. 50. Siam, 1997.

SEMESTER V

CSE 311: Artificial Intelligence [3-0-3-4]

Course Objectives

- To introduce the student about the principles of AI & techniques and do exercises in the laboratory to increase the subject understanding.

Course Outcomes

- Acquire a thorough knowledge and fundamental concepts and techniques of artificial Intelligence.
- Learn simulating tools and study AI language for problem solving
- To develop and test mini intelligent systems.

Syllabus

Introduction to Artificial Intelligence: Artificial Intelligence (AI), Major Branches of AI, Applications- Characteristics and Fundamental issues for AI problems, Steps to build Artificial intelligence (AI) systems, Intelligent systems, Characteristics of intelligent systems

Search Techniques: Why Search, Applications of search, Tree and Graph, Search strategies, Complexity of Search.

Knowledge Representation: Knowledge, Characteristics of knowledge representation, Types of knowledge representation, Propositional Logic, Tautology and Contradiction, Predicate Logic, Production Systems, Semantic network, Frame systems, Scripts.

Neural Networks: Introduction to Neural network, Structure of Neural network, Structure of Neural network, Neural Network Architecture, Network Layers, Neural Network Learning, Back-Propagation Algorithm.

Intelligent agents: Introduction to Agents, Functions, Examples of Agents

Intelligent Agent classification, Features of intelligent agents, Structure of Agents, Intelligent Agents Models Fuzzy logic: Crisp logic, Fuzzy logic, Member ship function, Member ship function, Fuzzy logic Applications.

Expert Systems: What is Expert system, Conventional systems vs. Expert systems, Basic Concepts, Human Expert Behaviors, Knowledge Types, Inferencing, Rules, Structure of Expert Systems, ES Components, Knowledge Engineer, Expert Systems Working, Problem Areas Addressed by Expert Systems, benefits-limitations- Applications of expert systems.

Text Books/References:

1. Sturat J Russell, Peter Norving. Artificial Intelligent: A Modern approach, Third Edition, 2015.
2. Elaine Rich and Kevin Knigh, Introduction to Artificial Intelligence, McGraw Hill, Third Edition, 2017.
3. Michael Negnevitsley, Artificial Intelligence: A guide to Intelligent Systems, Addison Wesley, Third Edition, 2017.
4. G.F. Luger, and W.A. Stubblefield, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Addison-Wesley Publishing Company, 2011
5. C.S. Krishnamoorthy and S. Rajeev, Artificial Intelligence and Expert Systems for Engineers by CRC Press, 1996.

CSE 313: Internet of Things [3-0-3-4]

Pre-requisites:

The participants should have prior knowledge on the following topics/courses:

• Computer Networks

• Digital Design and Electric Circuits.

• Fundaments of Programming

Course Objectives:

- To introduce the concept and the basics of IoT technologies,

- To provide knowledge on various applications of IoT based technologies and their associated circuits,
- To enable awareness on the different products that were designed based on IoT.

Course Outcomes:

- The students will have knowledge on various applications of IoT.
- The students will have practical knowledge on operating with sensors/actuators.
- The students will be capable to design their own IoT based applications using Arduino or Raspberry PI boards.

Syllabus

Introduction - Sensor basics, sensing and actuation, basics of networking - wired, wireless, MANET, PAN, wireless and wired protocols.

Communication protocols- IEEE standards, 5G era, sensor communications, connectivity challenges, fading and attenuation.

IoT architectures and programming – basic architectures, Data processing mechanisms, scalability issues, visualization issues, analytics basics, utility of cloud computing, fog computing, and edge computing, advanced IoT architectures Raspberry Pi and Arduino programming – Golang and Nodejs programming.

Applications - IoT for societal upliftment, industrial automation (Industry 4.0), smart city, smart home, smart transportation, smart healthcare, smart agricultures, golang based implementation.

Text Book/ References

1. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies Platforms, and Use Cases, CRC Press, First edition, 2017.
2. Honbu Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC press, First edition, 2012.
3. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, First edition, 2014.
4. Mung Chiang, Bharath Balasubramanian, Flavio Bonomi, Fog for 5G and IoT (Information and Communication Technology Series, Wiley series, First edition, 2017.
5. Alan A. A. Donovan, Brian W. Kernighan, The Go Programming Language, Addison- Wesley Professional Computing Series, First edition, 2015.

ECE 311: Digital Signal processing and its applications [3-0-3-4]

Course Objectives

- Understand the frequency domain sampling and reconstruction of discrete time signals.
- Study the properties and the development of efficient algorithms for the computation of DFT.
- Realization of FIR and IIR filters in different structural forms.
- Learn the procedures to design of IIR filters from the analog filters using impulse invariance and bilinear transformation.
- Study the different windows used in the design of FIR filters and design appropriate filters based on the specifications.
- Understand the architecture and working of DSP processor

Course Outcomes:

- Determine response of LTI systems using time domain and DFT techniques.
- Compute DFT of real and complex discrete time signals.
- Computation of DFT using FFT algorithms and linear filtering approach.
- Design and realize FIR and IIR digital filters
- Understand the DSP processor architecture

Syllabus

Discrete Fourier Transforms (DFT): Frequency domain sampling and Reconstruction of Discrete Time Signals, The Discrete Fourier Transform, DFT as a linear transformation, Properties of the DFT: Periodicity, Linearity and Symmetry

properties, Multiplication of two DFTs and Circular Convolution, Additional DFT properties.

Linear filtering methods based on the DFT: Use of DFT in Linear Filtering, Filtering of Long data Sequences. Fast-Fourier-Transform (FFT) algorithms: Efficient Computation of the DFT: Radix-2 FFT algorithms for the computation of DFT and IDFT–decimation-in-time and decimation-in-frequency algorithms.

Design of FIR Filters: Characteristics of practical frequency –selective filters, Symmetric and Antisymmetric FIR filters, Design of Linear-phase FIR filters using windows – Rectangular, Hamming, Hanning, Bartlett windows. Design of FIR filters using frequency sampling method.

Structure for FIR Systems: Direct form, Cascade form and Lattice structures

IIR Filter Design: Infinite Impulse response Filter Format, Bilinear Transformation Design

Method, Analog Filters using Lowpass prototype transformation, Normalized Butterworth Functions, Bilinear Transformation and Frequency Warping, Bilinear Transformation Design Procedure, Digital Butterworth Filter Design using BLT. Realization of IIR Filters in Direct form I and II.

Digital Signal Processors: DSP Architecture, DSP Hardware Units, Fixed point format, Floating point Format, IEEE Floating point formats, Fixed point digital signal processors, Floating point processors, FIR and IIR filter implementations in Fixed point systems.

Lab practice

Verification of sampling theorem (use interpolation function). Linear and circular convolution of two given sequences, Commutative, distributive and associative property of convolution.

Auto and cross correlation of two sequences and verification of their properties. Solving a given difference equation.

Computation of N point DFT of a given sequence and to plot magnitude and phase spectrum (using DFT equation and verify it by built-in routine). (i) Verification of DFT properties (like Linearity and Parseval's theorem, etc.) (ii) DFT computation of square pulse and Sinc function etc.

Design and implementation of Low pass and High pass FIR filter to meet the desired specifications (using different window techniques) and test the filter with an audio file.

Plot the spectrum of audio signal before and after filtering.

Design and implementation of a digital IIR filter (Low pass and High pass) to meet given specifications and test with an audio file. Plot the spectrum of audio signal before and after filtering.

Text Books/ References

1. Proakis & Monalakis, "Digital signal processing Principles Algorithms & Applications", 4th Edition, Pearson education, New Delhi, 2007. ISBN: 81-317-1000-9.
2. Li Tan, Jean Jiang, "Digital Signal processing Fundamentals and Applications", Academic Press, 2013,ISBN: 978-0-12-415893.
3. Sanjit K Mitra, "Digital Signal Processing, A Computer Based Approach", 4th Edition, McGraw Hill Education, 2013.
4. Oppenheim & Schaffer, "Discrete Time Signal Processing" , PHI, 2003.

IMA 313: Information Theory and Coding [3-0-0-3]

Course Objectives:

- To equip students with the basic understanding of the fundamental concept of entropy and information as they are used in communications.
- To enhance knowledge of probabilities, entropy, measures of information.
- To guide the student through the implications and consequences of fundamental theories and laws of information theory and coding theory with reference to the application in modern communication and computer systems

Course Outcomes:

- Calculate the information content of a random variable from its probability distribution.
- Relate the joint, conditional, and marginal entropies of variables in terms of their coupled probabilities.
- Define channel capacities and properties using Shannon's Theorems.
- Construct efficient codes for data on imperfect communication channels.
- Generalize the discrete concepts to continuous signals on continuous channels.

Syllabus:

Entropy, Relative Entropy Mutual information and its properties, entropy for discrete ensembles, Shannon's source coding theorem, Encoding of discrete sources, Kraft Inequality, Huffman Codes, Shannon Fano Elias Coding, Arithmetic coding; Channel capacity, Capacity of binary symmetric channel, erasure channels and other discrete channels, Shannon's noisy coding theorem and converse for discrete channels, Differential entropy, Application to continuous channels: Gaussian channel, Bandlimited channel, channels with coloured noise. Linear block codes, encoding and decoding of codes, syndrome decoding of linear codes, Convolutional codes, Viterbi decoding; Maximum likelihood decoding; Introduction to iterative codes and its sub-optimal decoding algorithms.

Text Books/References

1. Elements of Information Theory, T.M. Cover and J.A.Thomas, Wiley 19914
2. R. W.Yeung, A First Course in Information Theory, Kluwer Academic Publisher, 2002.
3. R. E. Blahut, Algebraic Codes for Data Transmission, Cambridge University Press, 2003.
4. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004, ISBN-13: 978 130426727.

ECE 312: Microwave Engineering [3-1-0-4]

Pre-requiste: Electromagnetic theory

Course Objectives:

- To inculcate understanding of the basics required for microwave circuits.
- To deal with the issues in the design of microwave amplifier.
- To instill knowledge on the properties of various microwave components.
- To deal with the microwave generation and microwave measurement techniques.

Course Outcomes:

Upon completion of the course, students will be able to:

- Explain the active & passive microwave devices & components used in Microwave communication systems.
- Generate Microwave signals and design microwave amplifiers.

Syllabus

Review of electromagnetics: Maxwell's equations, plane wave solutions;Transmission lines: coaxial lines, rectangular waveguides, Microstrip; Network analysis: scattering matrix, transmission matrix formulations;Matching networks: Lumped element designs and limitations, single and double-stub tuned designs, Quarter wavelength transformers, multi-section matching transformers; Active microwave circuit design: characteristics of microwave transistors, mixers and detectors, Oscillators; Amplifier design: LNA and Power amplifiers, gain and stability, design for noise figure, Single-stage amplifier design;Antenna Analysis and Design: Dipole, Monopole, Loop, Antenna arrays and Pattern synthesis, Complex Wire Antennas (Helical, Spiral, LPDA, Turnstile), Aperture antennas, Broadband and Ultra-wideband Antennas;

Noise in microwave circuits: dynamic range and noise sources, equivalent noise temperature, system noise figure considerations.

Text books/ References

1. David M. Pozar, 'Microwave Engineering,' 3rd. ed., John Wiley & Sons, 2005.
2. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.
3. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1 st Edition, Cambridge University Press, 2004
4. Robert E Colin, "Foundations for Microwave Engineering", John Wiley & Sons Inc, 2005

IHS 311: Human Resource Management [1-0-0-1]

Course Objectives

- To enable the students to understand the HR Management and system at various levels in general and in certain specific industries or organizations.
- To help the students focus on and analyse the issues and strategies required to select and develop manpower resources
- To develop relevant skills necessary for application in HR related issues
- To Enable the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions

Course Outcomes:

- To develop the understanding of the concept of human resource management and to understand its relevance in organizations.
- To develop necessary skill set for application of various HR issues.
- To analyse the strategic issues and strategies required to select and develop manpower resources.
- To integrate the knowledge of HR concepts to take correct business decisions.

Syllabus:

Introduction to Human Resource Management: Meaning, Function, Significance & Challenges of HRM, HR Policies, Introduction to Strategic Human Resource Management (SHRM), Introduction to HRP, Recruiting, Selecting & Socializing: Policy Issues, sources of people, selection process & tests, Socialization, Introduction to Internal Mobility, Training & Developing Workforce and Organizational Development, Performance Management System :Definition,Global Human Resource Management, Social Security and Labour Welfare

Text Books

1. George W Bohlander and Scott A Snell (2013), "Principles of Human Resource anagement". Fifteenth Edition"; Thomson Publications.
2. VSP Rao, "Human Resource Management", (2010), Excel Books, 3rd Edition

Reference Books

1. K Aswathappa, "Human Resource and Personal Management" (2017) Tata McGraw Hill, 8th Edition
2. Stephen P. Robbins, "Human Resource Management", (2002), Pearson Education Asia.
3. Sarah Gilmore and Steve Williams (2014). "Human Resource Management". Oxford University Press.
4. Tayeb, M. (2005). International human resource management. Oxford University Press.

IHS 312: Financial Management and Accounting [1-0-0-1]

Course Objectives:

- Provide the learner with an in-depth understanding of the link between company decision- making and the operation of capital markets

- Ensure the learner understands and appreciates the strong linkages between finance and globalisation
- Demonstrate the importance of working capital management and the tools to manage it
- Help the learner to explore the financial environment in which firms and managers must operate.

Course Outcomes:
On successful completion of this module, the learner will be able to:

- Describe the financial environment within which organisations must operate
- Critically evaluate the financial objectives of various types of organisations and the respective requirements of stakeholders
- Discuss the function of capital markets
- Explain alternative sources of finance and investment opportunities and their suitability in particular circumstances
- Assess the factors affecting investment decisions and opportunities presented to an organisation

Syllabus
Financial Accounting – An Introduction:Meaning of Accountancy, book-keeping and Accounting, Accounting Process , Objectives for accounting, Differences between book-keeping and accounting, Users of accounting information, Limitations of Accounting, Basic terminologies, Accounting Concepts, Principles, Bases and Policies Structure, Double Entry Accounting, Secondary Books. Purchases Book/Purchases Day book, Sales Book or Sales Day book, Bills receivable book, Trial Balance, Final Accounts: Adjustments before preparing final

accounts, Balance Sheet.

Introduction to Management Accounting: Management Accounting Framework , Tools of Management Accounting, The Balanced Scorecard, Cost Management System, Value Added Concept , Merits of Management Accounting, Demerits of Management Accounting , Distinction between Management Accounting and Financial Accounting, Funds Flow Analysis, Cash Flow

Analysis, Understanding Cost: Meaning of Cost, Objective of Costing, Methods of Costing, Budgetary Control: Meaning of a Budget, Budgetary control, Objectives of budgetary control.

References:

1. Narayanswami - Financial Accounting: A Managerial Perspective (PHI, 2nd Edition).
2. Mukherjee - Financial Accounting for Management (TMH, 1st Edition).
3. Ramchandran & Kakani - Financial Accounting for Management (TMH, 2nd Edition).
4. Ghosh T P - Accounting and Finance for Managers (Taxman, 1st Edition).
5. Maheshwari S.N & Maheshwari S K – An Introduction to Accountancy (Vikas, 9th Edition)
6. Ashish K. Bhattacharya- Essentials of Financial Accounting (PHI, New Delhi)
7. Ghosh T.P- Financial Accounting for Managers (Taxman, 3rd Edition)
8. Maheshwari S.N & Maheshwari S K – A text book of Accounting for Management (Vikas, 1st Edition)
9. Gupta Ambrish - Financial Accounting for Management (Pearson Education, 2nd Edition)
10. Chowdhary Anil - Fundamentals of Accounting and Financial Analysis (Pearson Education, 1st Edition).

IHS 313: Operations and Supply Chain Management [1-0-0-1]

Course Objectives:

- To understand the importance of supply chains with efficiency
- To understand different logistics of supply chain management

Course Outcomes:

After successfully completing the course the student should be able to:

- Explain and describe the strategic importance of optimized supply chains with high efficiency,
- Explain and describe the strategic role of procurement for the efficiency of supply chains,manage logistical issues such as purchasing, warehousing, queuing and production
- Simulate and optimize the elements of the logistics flow
- Develop policy options and perform decision analysis with regard to risk and forecasts regarding the supply and marketing strategies.

Syllabus:

Strategic planning and optimized design of the location, transportation, and internal and external flows (Supply Chain Management and Demand Chain Management). Models and methods of decision analysis in product development, sourcing and supplier strategies, outsourcing, strategic alliances, inventory management, and forecasting. Mathematical models for inventory optimization, demand planning, project planning, optimization in queues, general optimization, simulation, risk, game theory, and optimization of product selection.

Text Book/Reference:

1. Slack, Nigel, Operations and process management : principles and practice for strategic impact 3rd ed.: Harlow: Pearson Education, 2012.

SEMESTER VI

ECE 321 VLSI Design [3-0-3-4]

Pre-requisites:

Semiconductor devices, digital electronics.

Course Objectives:

- Study the fundamentals of CMOS circuits and its characteristics.
- Learn the design and realization of combinational & sequential digital circuits.
- Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology are discussed

Course Outcomes:

The learning outcomes for this course are as follows:

- Be able to create models of moderately sized CMOS circuits that realize specified digital functions.
- Have an understanding of the characteristics of CMOS circuit construction and the comparison between different state-of-the-art CMOS technologies and processes.
- Be able to complete a significant VLSI design project having a set of objective criteria and design constraints.

Syllabus:

Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS Technologies.

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, CMOS Design rules for wires, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits.

CMOS logic: PMOS, NMOS and CMOS, MOS transistors as a switch, CMOS inverter, Power Consumption: Static and Dynamic.

Designing Combinational Logic gates in CMOS: Static CMOS Design, Complementary CMOS , Ratioed Logic, Pass transistor logic, Dynamic CMOS design (Precharge and Evaluation) (Combinational circuits like NAND, NOR and other simple logics using CMOS).

Designing Sequential Logic Circuits: Timing Metrics for sequential Circuits, Setup time, hold time, propagation delay, Latches Vs Registers, Classification of Memory Elements

Datapath subsystem design: Adders, ALU, multipliers Implementation Strategies and testing for Digital ICs: Full Custom, Semicustom, Gate Array based design approaches, Programmable Logic Devices, Field Programmable Gate Arrays, Standard Cell based design, VLSI Design Flow Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Boundary Scan.

References:

1. Jan M Rabaey, Anantha Chandrakasan, Borivoje Nikolic. Digital Integrated Circuits: A design perspective
2. Michael John Sebastian Smith. Application Specific Integrated Circuits.
3. CMOS logic circuit Design - John .P. Uyemura, Springer, 2007.
4. Weste & Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4rd ed, Addison Wesley, 2010

ECE 322 Embedded Systems [3-0-3-4]

Pre-requisites:

Digital Electronics, Microprocessors.

Course Objectives:

This course will enable students to:

- Explain the architectural features and instructions of 32 bit microcontroller - ARM Cortex M3.
- Develop Programs using various instructions of ARM Cortex M3 and C language for different applications.

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Develop the hardware software co-design and firmware design approaches.
- Explain the need of real time operating system for embedded system applications.

Course Outcomes:

After studying this course, students will be able to:

- Describe the architectural features and instructions of 32 bit microcontroller ARM Cortex M3.
- Apply the knowledge gained for Programming ARM Cortex M3 for different applications.
- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- Develop the hardware software co-design and firmware design approaches.
- Explain the need of real time operating system for embedded system applications.

Syllabus:

Introduction to embedded systems and embedded processors. Embedded system architecture, classifications of embedded systems, challenges and design issues, CISC vs. RISC.

ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, Debugging support, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence.

ARM Cortex M3 Instruction Sets and Programming: Assembly basics, Instruction list and description, Thumb and ARM instructions, Special instructions, Useful instructions, CMSIS.

Embedded System Components: Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Elements of an Embedded System (Block diagram and explanation), Differences between RISC and CISC, Harvard and Princeton, Big and Little Endian formats, Memory (ROM and RAM types), Sensors, Actuators, Optocoupler, Communication Interfaces (I2C, SPI, IrDA, Bluetooth, Wi-Fi,

Zigbee only).

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modeling, Embedded firmware design and development.

RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task, scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program), How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil), Disassembler/decompiler, simulator, emulator and debugging techniques.

Textbooks /References

1. Embedded systems Architecture, Programming and design, Raj Kamal, second Edition, Tata MC Graw-Hill, 2008
2. Designing embedded systems with PIC microcontrollers: Principles and Applications, Tim Wilmshurst, Second Edition, Elsevier, 2005.
3. Embedded System design, Steve Heath, Second Edition, Newnes, 2002.
4. W.A. Smith, “ARM Microcontroller Interfacing: Hardware and Software, Eketor, 2010.
5. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd Edition, Newnes,

(Elsevier), 2010.
6. Steve Furber, "ARM System Architecture", Edison Wesley Longman, 1996.
7. William Hohl, "ARM Assembly Language- Fundamentals and Techniques ", CRC Press, 2009.

IOE xxxx Advanced Computer Architectures [3-0-0-3]

Course Objectives:
The objective of the course is to provide in-depth coverage of current and emerging trends in computer architecture focusing on performance and the hardware/software interface. The course emphasis is on analyzing fundamental issues in architecture design and their impact on application performance. Students have options in exploring their own interests in custom projects and assignments.

Course Outcomes:
A student who has successfully completed this course should be able to:

- Analyze various performance characteristics of a computer system.
- Apply digital design techniques to the microarchitecture construction of a processor.
- Translate assembly language programs to/from high-level language codes and algorithms.
- Analyze hardware & software trade-offs to design the instruction set architecture (ISA) interface.
- Understand advanced issues in design of computer processors, caches, and memory.
- Analyze performance trade-offs in computer design.

Syllabus:
Introduction to Computer Design and Quantitative Principles of Architecture Performance Analysis : Technology and computer trends, Measuring computer system performance, Benchmarks and metrics, CPI, Moore's law, Amdahl's Law.

Instruction Set Principles and Examples: Classification of Instruction Set Architectures (ISA) – RISC, CISC, VLIW, EPIC, Predicated execution and compiler-controlled speculation

Advanced Microarchitecture and Instruction-Level Parallelism : Superscalar and pipeline

operation, Instruction-Level Parallelism (ILP)

Memory-Hierarchy Design: Multi-level cache design issues , Performance evaluation.

Architecture Implementation Issues and Analysis: Power- Dynamic Voltage Frequency Scaling (DVFS), Energy-Delay Product (EDP), Architecture physical layer concepts including device&layout, manufacturing constraints, architectures, defect tolerance

Text book:

1. Hennessy and Patterson, Computer Architecture- A Quantitative Approach, 4th or later Edition (ISBN-13: 978-0123704900 ISBN-10: 0123704901 Edition: 4th).
2. Kai Hwang and Naresh Jotwani, Advanced Computer Architecture (SIE): Parallelism, Scalability, Programmability, McGraw Hill Education 3/e. 2015.

IOE xxxx Computer Vision [3-0-0-3]

Course Objectives:
- To introduce students the fundamentals of image formation;
- To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition;
- To develop an appreciation for various issues in the design of computer vision and object recognition systems
- To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes:
After completing the course you will be able to:

- Identify basic concepts, terminology, theories, models and methods in the field of computer vision,

- Describe known principles of human visual system,
- Describe basic methods of computer vision related to multi-scale representation, edge detection, detection of other primitives, stereo, motion and object recognition.

Syllabus:

Introduction to computer vision, geometric camera models, light and shading, local image

features: SIFT, HOG, texture and shape descriptors, active contour, segmentation, deformable models, RANSAC, image registration, learning and classification strategies, image classification, object detection and recognition, stereopsis, tracking, applications.

Text Books/References:

1. Forsyth and Ponce, "Computer vision: a modern approach," 2 nd Ed., Pearson, 2012.
2. Sonka, Hlavac and Boyle, "Digital image processing and computer vision," Cengage learning, 2008.
3. Rick Szeliski, "Computer Vision: Algorithms and Applications," Springer,2011.

IOE xxxx Wireless Sensor Networks [3-0-0-3]

Course Objectives:

- To Understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology
- Understand the medium access control protocols and address physical layer issues
- Learn key routing protocols for sensor networks and main design issues
- Learn transport layer protocols for sensor networks, and design requirements
- Understand the Sensor management ,sensor network middleware, operating systems.

Course Outcomes:

- Have knowledge and understanding of basic WSN technology and supporting protocols and Technology
- Have knowledge and to Identify medium access control protocols and address physical layer issues
- Have knowledge routing protocols for sensor networks and main design issues
- Have knowledge of transport layer protocols for sensor networks, and design requirements
- Understand Sensor management, sensor network middleware, operating systems

Syllabus:

Introduction and Overview of Wireless Sensor Networks :Introduction, Background of Sensor Network Technology, Applications of Sensor Networks, Basic Overview of the Technology,Basic Sensor Network Architectural Elements, Brief Historical Survey of Sensor Networks, Challenges and Hurdles, Applications of Wireless Sensor Networks, Basic Wireless Sensor Technology- Introduction, Sensor Node Technology-Overview,Hardware and Software,Sensor Taxonomy, WN Operating Environment, WN Trends.

Wireless Transmission Technology and Systems: Introduction, Radio Technology Primer, Propagation and Propagation Impairments, Modulation, Available Wireless Technologies, Campus Applications, MAN/WAN Applications, Medium Access Control Protocols for Wireless Sensor Networks, Schedule-Based Protocols, Random Access-Based Protocols, Sensor-MAC Case Study Routing Protocols for Wireless Sensor Networks:Data Dissemination and Gathering, Routing

Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies, Transport Control Protocols , Middleware for Wireless Sensor Networks, WSN Middleware Principles, Middleware Architecture, Existing Middleware.

Network Management for Wireless Sensor Networks: Requirements, Traditional Network

Management Models, Simple Network Management Protocol, Telecom Operation Map, Network Management Design Issues

Operating Systems for Wireless Sensor Networks

TEXT BOOKS:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati: Wireless Sensor networks, Technology, Protocols, and Applications -John Wiley & Sons, 2007.
2. William C Y Lee: Mobile Communications Engineering Theory and Applications, 2nd Edition, McGraw Hill Telecommunications 1998.
3. William Stallings: Wireless Communications and Networks, Pearson Education Asia, 2002.

IOE xxxx Cloud Computing [3-0-0-3]

Course Objectives:

The main objectives of this course are:

- To gain knowledge on virtualization techniques.
- To frame VM clusters.
- To migrate or consolidate VM machines.
- To understand the working methodology of existing clouds, such as, Amazon, Opennebula, and so forth.
- To learn how to program clouds using new programming models.

Course Outcomes:

- the students will learn the basic technologies for cloud.
- Apply appropriate cloud services for their applications.
- Design cloud services using golang or nodejs.
- Learn how to program public clouds such as AWS or GCE.

Syllabus:

Base Technologies - Review: Introduction, Grid Computing, Cluster, P2P computing, and so forth, System Models for Distributed and Cloud computing.

Virtualization:Virtualization concepts, levels of Virtualization, VM Tools and mechanisms,

Virtualization of CPU, Memory, and I/o devices, VM server consolidation, VirtualBox,

VMWare Vsphere - Datacenter Automation.

Cloud Infrastructure / Architectures: Design Challenges of Clouds, Public cloud platforms.

GCE, AWS, Azure, Resource Management in Clouds, cloud environments - openstack and

opennebula, security aspects of clouds, Storage aspects of clouds, introduction to programming models.

Advanced topics: Kubernetes, Docker containers, DevOps, Cloud Networking - SDN, HPC in cloud, IoT cloud, Microservices.

Lab Components:

VMs using virtualbox, VMs using AWS, server automation using VMwareCloud, cloud services, Kubernetes, OpenStack or OpenNebula.

Text Books/References

1. Kai Hwang, Geoffrey C. Fox, Jack K. Dongarra, Distributed and Cloud Computing: From parallel processing to Internet of Things, Morgen Kauffmann 2013.
2. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Pearson publishers, 2016.
3. Jonathan Baier, Getting Started with Kubernetes: 2nd Edition, Packt publishers, 2015.
4. Hideto Saito, Hui-Chuan Chloe Lee, and Cheng-Yang Wu, DevOps with Kubernetes-Accelerating software delivery with container orchestrators, Packt publishers, 2017.
5. Gigi Sayfan, Mastering Kubernetes: Large scale container deployment and management, Packt publishers, 2016.
6. Kevin Hoffman and Dan Nemeth, Cloud Native Go: Building Web Applications and Microservices for the Cloud with Go and React (Developer's Library), Pearson publishers, 2016.

7. Bob Familiar, Microservices, IoT, and Azure: Leveraging DevOps and Microservice Architecture to deliver SaaS Solutions, Apress publishers, 2015.
8. Dirk Slama, Frank Puhlmann, Jim Morrish, and Rishi M. Bhatnagar, Enterprise IoT: Strategies and Best practices for Connected products and services, O'Rielly publishers, 2015.

ECE xxxx Advanced Communication Networks [3-0-0-3]

Course Objectives:
This is a graduate level course on advanced computer communication and networking

technologies. Major objectives are:

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks.
- To learn the functions of network layer and the various routing protocols.
- To familiarize the functions and protocols of the Internet servers

Course Outcomes:
Upon successful completion of this course, the student will be able to:

- Understand the basic layers and its functions in Communication networks.
- Design and develop protocols for Communication Networks.
- Understand the basics mechanisms in Quality of Service in networking.
- Analyze and design routing algorithms.
- Design protocols for various functions in the network

Syllabus:
Overview of Internet-Concepts, challenges and history. Overview of - ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.;Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP). Leaky bucket algorithm and its properties

Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service

connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.; Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

IP address lookup-challenges. Packet classification algorithms and Flow Identification-Grid of Tries, Cross producting and controlled prefix expansion algorithms.

Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.

IPV4, IPV6, IP tunnelling, IPswitching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

Text Books
1. Jean Wairand and Pravin Varaiya, “High Performance Communications Networks”, 2 nd edition, 2000.
2. Jean Le Boudec and Patrick Thiran, “Network Calculus A Theory of Deterministic Queueing Systems for the Internet”, Springer Veriag, 2001.
3. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.
4. Anurag Kumar, D. Manjunath and Joy Kuri, “Communication Networking: An

Analytical Approach" , Morgan Kaufman Publishers, 2004.
5. George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005

ECE xxxx Automotive Electronics [3-0-0-3]

Course Objectives:
This course will enable students to:

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

Course Outcomes:

- Explain the electronics systems used for control of automobiles
- Select sensors, actuators and control systems used in automobiles
- Diagnose the faults in the sub systems and systems used automobile

Syllabus:
Automotive Fundamentals Overview –Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery – Operating principle.

The Basics of Electronic Engine Control – Motivation for Electronic Engine Control – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system.

Analysis of intake manifold pressure, Electronic Ignition. Control Systems - Automotive Control System applications of Sensors and Actuators – Typical Electronic Engine Control System, Digital Engine Control Systems

Control Units –Operating conditions, Design, Data processing,Programming, Digital modules in

the Control unit, Control unit software.

Automotive Networking – Bus Systems– Classification, Applications in the vehicle, Coupling of networks Vehicle Motion Control – Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS), Future Automotive Electronic Systems – Alternative Fuel Engines, Electricand Hybrid vehicles,

Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation – Navigation Sensors – Radio Navigation,Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving.

Text Books:
1. William B.Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley& Sons Inc., 2007.

ECE xxxx Nanoelectronics [3-0-0-3]

Course Objectives:
The course intends to give students a broad understanding of fundamentals, fabrication

technologies and applications of nanoscale structures. Students will also be trained for literature study and critique, oral presentation, problem formulation, solution development, and formal writing.

Course Outcomes:
The student will be able to explain the significance of current research about a particular topic in nanoelectronics

Syllabus:
Introduction (from classical electronics to nanoelectronics) Wave-particle duality, Schrödinger wave equation, Materials for nanoelectronics - Semiconductors - Carbon nanomaterials nanotubes.

Electrons in low-dimensional structures - Electrons in quantum wells - Electrons in quantum wires - Electrons in quantum dots, Fabrication of nanostructures - Crystal growth - Nanolithography - Clusters and nanocrystals - Nanotube growth - Characterization of nanostructures

Electron transport in semiconductors and nanostructures - Time and length scales of the electrons

in solids - Statistics of the electrons in solids and low-dimensional structures - Electron transport in nanostructures

Nanoelectronic devices - Resonant-tunneling diodes - Field-effect transistors – Single-electron-transfer devices.

Text Books/ References

1. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "Introduction to Nanoelectronics", Cambridge University Press, 2008. (ISBN: 9781107403765)
2. George W. Hanson, "Fundamentals of nanoelectronics", Pearson/Prentice, 2008. Quantum Mechanics
3. D. J. Griffiths, "Introduction to quantum mechanics (2nd edition)", Prentice Hall, 2005. Solid- state physics
4. R. Turton, "The physics of solids", Oxford, 2000. Semiconductor physics and devices
5. S. M. Sze, "Physics of Semiconductor Devices (2nd)", Wiley, 1981
6. S. Datta, "Lessons from Nanoelectronics: A New Perspective on Transport (Lessons from Nanoscience: a Lecture Notes Series) World Scientific, 2012
7. V. Mitin, V. Kochelap, and M. Stroscio "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2008.
8. C. P. Poole and F. J. Owens, "Introduction to nanotechnology", John Wiley & Sons, 2003

ECE xxxx Biomedical Signal Processing [3-0-0-3]

Course Objectives:
- To understand the basic signals in the field of biomedical.
- To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, evoked potentials, and EMG.
- To understand Sources and characteristics of noise and artifacts in bio signals.
- To understand use of bio signals in diagnosis, patient monitoring and physiological investigation
- To explore research domain in biomedical signal processing

Course Outcomes:
After successfully completing the course students will be able to:

- The student will be able to model a biomedical system.
- The student will be able to understand various methods of acquiring bio signals.
- The student will be able to understand various sources of bio signal distortions and its remedial techniques.
- The students will be able to analyze ECG and EEG signal with characteristic feature points.

- The student will have a basic understanding of diagnosing bio-signals and classifying them.

Syllabus:

Biomedical Signals: Bioelectric Signals and Electrodes: Bio-potentials and their origin: ECG, EEG, EMG, ENG, ERG, EOG, MEG. Biomedical Instrumentation System, biomedical transducers, electrodes and their characteristics. Origin of bio potentials. Sources and contamination of Noise in bio signals. Classification of biomedical signals.

Cardio Vascular and Nervous System: Cardiovascular system, Coronary and Peripheral Circulation, Electrical Activity of the heart, Lead configurations , ECG data acquisition, ECG recorder, Concept of Blood Pressure Measurement, Nervous System: Structure and functions of Neurons, Electrical activity of nerve cell, Synapse, Reflex action and Receptors. Analysis of Electrical Activity of Heart : ECG signal parameters & their estimation - Use of multiscale analysis for ECG parameters estimation, Noise & Artifacts, ECG Signal Processing: QRS detection, Highlight the Feature points of ECG and its classification for Normal and Abnormal state using Multilayer Perceptron. Analysis of Electrical Activity of Brain 6L Electroencephalogram – Structure of brain, EEG signal acquisition, EEG rhythms & waveform - categorization of EEG activity – recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Use of Fourier Transform in EEG Signal Analysis.

Analog Signal Processing: Basics of Instrumentation Amplifier, Isolation amplifier, Grounding and shielding techniques. Integer Filters: Basic design Concept, Low Pass and High Pass Filters, Band Pass, Band Stop and Band Reject Filters. Its application in Biomedical field. Adaptive Filters: Basic Concepts.

Digital signal Processing: Characteristics, frequency domain representation; Stationary and non- stationary bio-signals, waveform detection, Sampling Theory, Finite data considerations (Edge effects), Z Transform, FIR and IIR filters specific to event detection of ECG. Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis like PCA and ICA.

Text books

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, 4 th Edition, Prentice Hall, 2000. 2. R. Rangayan, “Biomedical Signal Analysis”, Wiley 2002. 3. John
2. Semmlow, “Bio-signal and Biomedical Image Processing”, Marcel Dekker.
3. R.S.Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003, Edition-II.
4. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, 4 th Edition, Prentice Hall, 2000.
5. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2001
6. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier.
7. C.Reddy “Biomedical Signal Processing: Principles and techniques”, Tata McGraw Hill, New Delhi, 2005.
8. Willis J Tompkins, “Biomedical Signal Processing”, ED, Prentice – Hall, 1993.

CSE 321 Machine Learning [3-0-3-4]

Pre-requisites: Calculus & Linear Algebra; Programming & Data Structure Course

Course Objectives:

- To provide an in-depth introduction to supervised, unsupervised and reinforcement learning algorithms.
- To design and implement machine learning solutions to classification, regression, and clustering problems.

Course Outcomes:

At the end of the course the students will be able to:

- Develop an appreciation for what is involved in learning from data.
- Understand a wide variety of learning algorithms.
- Understand how to apply a variety of learning algorithms to data.
- Understand how to perform evaluation of learning algorithms and model selection.

Syllabus:

Review of linear algebra, optimization and probability: Matrices, Eigen values and vectors, gradient, hessian, least squares, optimization; random variables and distributions

Definitions, goals and history of Machine Learning; Introduction, linear classification; Classification errors; Regression Techniques

Supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines);

Unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance trade-offs; VC theory; large margins);

Reinforcement learning and adaptive control. Applications of machine learning.

Text books/ References

1. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997.
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006
3. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
4. Hastie, T., R. Tibshirani, and J. H. Friedman. The Elements of Statistical Learning: Data Mining, Inference and Prediction, Second Edition, Springer, 2009
5. MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003.

ISC 321 High Performance and Scientific Computing [3-0-0-3]

Course Objectives:

- To explore complex systems, we require computational methods since mathematical models are only rarely solvable algebraically. This course is aimed at providing numerical methods to solve algebraic, transcendental and differential equations, and to calculate definite integral and derivative.
- This course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs.

Course Outcomes:

- Devise an algorithm to solve it numerically
- Analyze an algorithm's accuracy, efficiency and convergence properties
- Establishing the limitations, advantages, and disadvantages of numerical methods

Syllabus:

Numerical Methods Solutions of Linear systems:- Gaussian elimination; Gauss Siedal method,

LU decompositions; Iterative methods for nonlinear equations:- Newton's method, Regula-Falsi

method, error analysis for iterative methods Interpolation: Lagrange polynomial, divided

differences, Hermite Interpolation, cubic spline Interpolation. Numerical differentiation, Richardson's extrapolation, Newton-Cotes formulas,composite numerical integration, Romberg

integration, adaptive quadrature, Gaussian quadrature. Initial value problems(IVP) for ordinary differential equations - Euler method, Runge- Kutta methods Boundary Value Problems (BVP):

Finite difference method, collocation method, Galerkin method.

High Performance Computing: Single-processor performance, memory hierarchy, and pipelines.

Overview of parallel system organization and parallel computing. Introduction to message

passing and MPI programming;

References:

1. S. R. K. Iyengar, R. K. Jain, M. K. Jain Numerical Methods for Scientific and Engineering Computation, 6 th Edition, New Age International, 2012.
2. Sankara Rao, Numerical methods for Scientist and Engineers, PHI, 2007
3. Amos Gilat, Numerical methods for Engineers and Scientist, Wiley, 2014
4. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981
5. R.L. Burden and J. D. Faires, Numerical Analysis, Seventh Edition, Brookes/Cole, 2011.
6. C. T. Kelly, Iterative Methods for Linear and Nonlinear Equations, SIAM, Philadelphia, 1995
7. A. Greenbaum, Iterative Methods for Solving Linear Systems, SIAM, Philadelphia, 1997
8. O. Axelsson, Iterative Solution Methods, Cambridge University Press, 1994
9. Kendall E. Atkinson, An Introduction to Numerical Analysis, Second Edition, John Wiley,
10. F.B. Hildebrand, Introduction to Numerical Analysis, McGraw Hill, NewYork, 1974.
11. C.F. Gerald and P.O. Wheately, Applied Numerical Analysis, fifth Edition, AddisonWesley,1994.
12. George Em Karniadakis and Robert M Kirby, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their implementation, Cambridge University Press, 2003
13. Victor Eijkhout, Introduction to High Performance Scientific Computing, 2014.

SEMESTER VII

ECE 411 FPGA based System Design [3-0-3-4]

Course Objectives

- To understand FPGA basics.
- To learn application of FPGA in reconfigurable computing
- To learn case studies.
- To expose students to HDL programming.

Course Outcomes

- Have understood the necessity of reconfigurable architectures.
- Have learned the basic modules of HDL.
- Develop applications using FPGA.

Syllabus

General Purpose Computing Vs Reconfigurable Computing – Simple Programmable Logic Devices – Complex Programmable Logic Devices – FPGAs – Device Architecture - Case Studies.

Compute Models - Programming FPGA Applications in HDL – Compiling C for Spatial Computing – Operating System Support for Reconfigurable Computing.

The Design Flow - Technology Mapping – FPGA Placement and Routing – Configuration Bitstream Generation – Case Studies with Appropriate Tools.

Case Studies of FPGA Applications – System on a Programmable Chip (SoPC) Designs.

TextBooks/References

1. Maya B. Gokhale and Paul S. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer, 2005.
2. Scott Hauck and Andre Dehon (Eds.), "Reconfigurable Computing – The Theory and Practice of FPGA-Based Computation", Elsevier / Morgan Kaufmann, 2008.
3. Christophe Bobda, "Introduction to Reconfigurable Computing – Architectures, Algorithms and Applications", Springer, 2010.

ECE 412 Antenna Theory and Design [3-1-0-4]

Course Objectives

- To understand antenna and radiations.
- To learn application of antennas in micro-ranges.
- To learn how radiation happens through antennas.
- To expose students to newer antenna concepts.

Course Outcomes

- Have understood the necessity of antennas.
- Have learned the basic radiation patterns of antennas.
- Have understood the applications of antennas.

Syllabus

Antenna fundamental parameters, Radiation integrals ,Radiation from surface and line current distributions – dipole, monopole, loop antenna; Mobile phone antenna- base station, hand set antenna; Image; Induction ,reciprocity theorem, Broadband antennas and matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.

Introduction-General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beam forming matrices-Active modules, digital beam forming,

MEMS technology in phased arrays-Retro directive and self phased arrays.

Radiation Mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Application of microstrip array antenna.

Textbooks/References

1. Hubregt.J.Visser "Antenna Theory and Applications" 1st Edition, John Wiley & Sons Ltd, Newyork, 2012.
2. Zhijun Zhang" Antenna Design for Mobile Devices" 1st Edition, John Wiley & Sons (Asia) Ltd, Newyork,2011.
3. Xavier Begaud, "Ultra Wide Band Antennas" , 1st Edition, ISTE Ltd and John Wiley & Sons Ltd, Newyork,2013.

ECE xxxx System on Chip Design [3-1-0-4]

Objectives of the course

- To design combinational and sequential logic networks.
- To learn design principles of FPGA and PLAs.
- To learn various floor planning methods for system design.
- To learn optimization of power.

Outcomes of the course

- Have understood the design principles of digital systems.
- Have learned the design aspects of FPGA and PLAs.
- Have understood the applications of SoC.

Syllabus

Introduction. Combinational Logic Functions. Static Complementary Gates. Switch Logic. Alternative Gate Circuits. Low-Power Gates. Delay Through Resistive Interconnect. Delay Through Inductive Interconnect.

Introduction. Standard Cell-Based Layout. Simulation. Combinational Network Delay. Logic and interconnect Design. Power Optimization. Switch Logic Networks. Combinational Logic Testing.

Introduction. Latches and Flip-Flops. Sequential Systems and Clocking Disciplines. Sequential System Design. Power Optimization. Design Validation. Sequential Testing.

Introduction. Subsystem Design Principles. Combinational Shifters. Adders. ALUs. Multipliers. High- Density Memory. FieldProgrammable Gate Arrays. Programmable Logic Arrays. References.

Problems.
Introduction, Floor-planning Methods – Block Placement & Channel Definition, Global Routing, switchbox Routing, Power Distribution, Clock Distributions, Floor-planning Tips, Design Validation.

Off-Chip Connections – Packages, The I/O Architecture, PAD Design.

Textbooks/References

1. Wayne Wolf, "Modern VLSI Design – System – on – Chip Design", Prentice Hall, 3rd Edition 2008.
2. Wayne Wolf, "Modern VLSI Design – IP based Design", Prentice Hall, 4th Edition , 2008.

IOE xxxx Cryptography and Network Security [3-0-0-3]

Course Objectives

- To lay a foundation on Security in Networks, attacks, defence and Classical Cryptosystems
- To analyse various Private and Public key Cryptosystems to ensure confidentality, Integrity and Authentication.
- To analyse various protocols to ensure Email Security and Network Security.
- To apply Cryptography in various Applications.

Course Outcomes

- Understand the fundamental concepts of Cryptography, Types of Security breaches, attacks, defence, control measures, Classical Cryptosystem.
- Compare various Private and Public key Cryptosystems to ensure confidentality, Integrity and Authentication.
- Understand various protocols in Email Security and Network Security.
- Apply Cryptograhy in various Applications.

Syllabus

Introduction to Security in networks, Types of Security breaches, attacks, defence, control measures, Classifying cryptosystems, classical cryptosystems, block cipher modes of operation, DES encryption and decryption, triple DES, AES encryption and decryption.

Public Key Cryptosystem - RSA cryptosystem, Diffie-Hellman Key Exchange Algorithm, Elliptic curve cryptosystem, Message Authentication and Hash Function- MD5 message digest algorithm, Secure hash algorithm, Authentication Protocols and Digital signature,DSS.

Kerberos - X.509 Authentication Service. – Pretty Good Privacy - Electronic Mail Security – IP Security Architecture – Web Security Considerations – Secure Socket Layer and Transport Layer Security – Secure Electronic Transaction –Firewalls – Firewall Design Principles

Applications of Cryptography- Blockchain,

Bitcoin and Cryptocurrency Technologies

Text Books/References

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security, 3rd Edition, Mc Graw Hill Education, 2016.
2. Stallings W., Cryptography and Network security: Principles and Practice, 7/e, Pearson Education Asia, 2017.
3. Charles P. Pleeger, Shari Lawrence Pfleeger, “Security in Computing”, Pearson Education Asia, 4th Edition, 2009.
4. Alan T. Norman, “Blockchain Technology Explained: The Ultimate Beginner’s Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts” Kindle Edition, 2017.
5. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies” 1st Edition, 2014.
6. Matthew Connor, “Blockchain: Ultimate Beginner's Guide to Blockchain Technology - Cryptocurrency, Smart Contracts,Distributed Ledger, Fintech, and Decentralized Applications” Kindle Edition, 2017.

SEMESTER VIII

ECE xxxx Real Time Embedded Systems [3-0-0-3]

Objectives of the course

- To understand processors and their instruction sets .
- To understand hardware platform for embedded systems.
- To design and analysis programs for embedded systems.
- To understand distributed and multi-processor embedded systems.

Outcomes of the course

- Have understood the approach to develop assembly code for processors.
- Have learned to perform platform level performance analysis.
- Have understood develop applications using RTOS.

Syllabus

Introduction to embedded computing – overview of embedded system design process – instruction sets of processors: ARM, PIC, TI C55x, TI C64x – programming I/O – modes and exceptions – coprocessors – memory system – CPU performance – CPU power consumption

Basic computing platforms – CPU Bus – memory devices and systems – choosing a platform – development environments – debugging – consumer electronics architecture – platform-level performance analysis – design example: Audio Player

Components for embedded programs – models of programs – Assembly, linking, and loading – compiler optimizations – program-level performance analysis – performance optimization – program-level energy optimization – optimizing program size – program validation and testing – design example: Digital Still Camera

System design methodologies – requirements analysis – specifications – architecture design – quality assurance – distributed embedded systems – shared-memory multiprocessors – design example: Video accelerator

Textbooks/References

1. Christopher Hallinan, "Embedded Linux Primer: A Practical Real-World Approach", Second Edition, Prentice Hall, 2010.
2. Karim Yaghmour et al., "Building Embedded Linux Systems", O'Reilly, 2008.
3. Arnold S. Berger, "Embedded Systems Design: An Introduction to Processes, Tools, and Techniques", CMP Books, 2001.
4. David E. Simon, "An embedded Software Primer", Addison-Wesley, 1999.

ECE xxxx Wireless and Cellular Communication [3-0-3-4]

Objectives of the course

- Understand the concepts of propagation over wireless channels from a physics standpoint
- Application of Communication theory both Physical and networking to understand GSM systems that handle mobile telephony
- Application of Communication theory both Physical and networking to understand CDMA systems that handle mobile telephony.
- Application of Communication theory both Physical and networking to understand LTE-4G systems.

Outcomes of the course

- Explain concepts of propagation mechanisms like Reflection, Diffraction, Scattering in wireless channels.
- Develop a scheme for idle mode, call set up, call progress handling and call tear down in a GSM cellular network.
- Develop a scheme for idle mode, call set up, call progress handling and call tear down in a CDMA cellular network.
- Understand the Basic operations of Air interface in a LTE 4G system.

Syllabus

Mobile Radio Propagation- Large Scale Path Loss - Free Space Propagation Model, Relating Power to Electric Field, Three Basic Propagation Mechanisms-Reflection (Ground Reflection) , Diffraction, Scattering, Practical Link Budget.

Fading and Multipath-Broadband wireless channel, Delay Spread and Coherence Bandwidth, Doppler Spread and Coherence Time, Angular spread and Coherence Distance. Statistical Channel Model of a Broadband Fading Channel.

The Cellular Concept – Cellular Concept, Analysis of Cellular Systems, Sectoring.

GSM and TDMA Technology: GSM System overview – Introduction, GSM Network and System Architecture, GSM Channel Concept.

GSM System Operations - GSM Identities, System Operations –Traffic cases, GSM

Infrastructure Communications (Um Interface).

CDMA Technology: CDMA System Overview – Introduction, CDMA Network and System Architecture.

CDMA Basics – CDMA Channel Concepts, CDMA System (Layer 3) operations, 3G CDMA.

LTE – 4G: Key Enablers for LTE 4G – OFDM, SC-FDE, SC-FDMA, Channel Dependant Multiuser.

Resource Scheduling, Multi-Antenna Techniques, Flat IP Architecture, LTE Network Architecture.

Multi-Carrier Modulation – Multicarrier concepts, OFDM Basics, OFDM in LTE, Timing and Frequency Synchronization, Peak to Average Ration, SC-Frequency Domain Equalization, Computational Complexity Advantage of OFDM and SC-FDE.

LTE – 4G: OFDMA and SC-FDMA – Multiple Access for OFDM Systems, OFDMA, SCFDMA, Multiuser Diversity and Opportunistic Scheduling, OFDMA and SC-FDMA in LTE, OFDMA system Design Considerations.

The LTE Standard – Introduction to LTE and Hierarchical Channel Structure of LTE, Downlink OFDMA Radio Resources, Uplink SC-FDMA Radio Resources.

Textbooks/References

1. Fundamentals of LTE" Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, Pearson education (Formerly Prentice Hall, Communications Engg and Emerging Technologies), ISBN-13: 978-0-13-703311-9.
2. "Introduction to Wireless Telecommunications Systems and Networks", Gary Mullet, First Edition, Cengage Learning India Pvt Ltd., 2006, ISBN - 13: 978-81-315-0559-5.
3. "Wireless Communications: Principles and Practice" Theodore Rappaport, 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 2002, ISBN 0-13-042232-0.
4. LTE for UMTS Evolution to LTE-Advanced' Harri Holma and Antti Toskala, Second Edition -2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003. 2

ECE xxxx Multimedia Communication [3-0-3-4]

Objectives of the course

- To understand multimedia networking .
- To understand reliable transport protocol and applications.
- To understand broadband network technology.
- To understand a few multimedia protocols.

Outcomes of the course

- Have understood the applications of multimedia networking.
- Have learned about distributed virtual reality.
- Have understood multimedia compression techniques.

Syllabus

Digital Sound, Video and Graphics – Basic Multimedia Networking – Multimedia Characteristics – Evolution of Internet Services Model – Network Requirements for Audio/ Video Transform – Multimedia Coding and Compression for Text, Image Audio And Video.

Broadband Services – ATM and IP, IPV6, High Speed Switching – Resource Reservation, Buffer Management – Traffic Shaping – Caching – Scheduling and Policing, Throughput, Delay and Jitter Performance – Storage and Media Services – Voice and Video Over IP – MPEG–2 over ATM/IP – Indexing Synchronization of Requests – Recording and Remote Control .

Multicast over Shared Media Network – Multicast Routing and Addressing – Scaling Multicast and NBMA Networks – Reliable Transport Protocols – TCP Adaptation Algorithm – RTP, RTCP – MIME. Peer–to–Peer Computing – Shared Application – Video Conferencing, Centralized and Distributed Conference Control – Distributed Virtual Reality – Light Weight Session Philosophy.

Textbooks/References

1. Ivan Vidal, Ignacio Soto, Albert Banchs, Jaime Garcia, Ivan Lozano, Gonzalo Camarillo, Multimedia Networking Technologies, Protocols, Architectures, in Artech Publishers, 2019.
2. B O Szuprowicz, "Multimedia Networking", McGraw Hill, Newyork, 1995.
3. K R Rao, Zoran S, Bojkovic and Dragorad A, Milovanovic "Multimedia communication systems", PHI, 2003.
4. Jon Crowcroft, Mark Handley, Ian Wakeman "Internetworking Multimedia" Harcourt, Singapore, 1998.
5. Tay Vaughan,"Multimedia Making it to work", 4th edition Tata McGraw Hill, New Delhi, 2000.

IOE xxxx Deep Learning [3-0-0-3]

Pre-requisite: Machine Learning

Course Objectives:

- The objective of this course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short-term memory cells and convolutional neural networks.
- The course also requires students to implement programming assignments related to these topics.

Course Outcomes:

- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- Implement deep learning algorithms and solve real-world problems.

Syllabus

Introduction: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization.

Deep Neural Networks: Difficulty of training deep neural networks, Greedy layerwise training.

Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Convolutional Neural Networks: Architectures, convolution / pooling layers , LeNet, AlexNet.

Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and

Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

Deep Unsupervised Learning and Recent Trends: Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, Adversarial Generative Adversarial Networks, Autoencoder and DBM, Multi- task Deep Learning, Multi-view Deep Learning.

Applications of Deep Learning to Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks.

Applications of Deep Learning to NLP:

Introduction to NLP and Vector Space Model of Semantics Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning

Text Books/References

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006
3. Raúl Rojas, Neural Networks : A Systematic Introduction, Springer, 1996