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 COMPUTER SCIENCE AND ENGINEERING

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BTech-MS Course Structure

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
ICS 111	IT Workshop I	3	1	3	5	IEC 121	Electronic Circuits and Measurements	3	1	3	5
ICS 112	Computer Programming	3	1	3	5	ICS 121	Data Structures	3	1	3	5
IEC 111	Digital Design and Electric Circuits	3	1	3	5	ICS 122	Computer Organization	3	1	0	4
IHS 111	Communication Skills	3	0	0	3	ICS 123	IT Workshop II	2	1	3	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	IHS 122	Foreign Language	1	0	0	1
Total		**16**	**4**	**11**	**23**	**Total**		**16**	**5**	**9**	**24**
Cumulative Credits at the End of First Year: 47											
Semester –III						**Semester -IV**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
IMA 211	Differential Equations and Transforms	3	1	0	4	ICS 221	Theory of Computation	3	1	0	4
ICS 211	Design and Analysis of Algorithms	3	1	0	4	ICS 222	OOAD	3	0	3	4
ICS 212	Operating Systems	3	1	0	4	ICS 223	Complier Design	3	0	3	4
ICS 213	Databases Management Systems	2	1	3	4	ICS 224	Computer Networks	3	0	3	4
ICS 214	IT Workshop III	2	1	3	4	IMA221	Probability, Statistics and Random Processes	3	1	0	4
ISC 211	Introduction to Bioinformatics	3	0	0	3	IHS 221	Fundamentals of Economics	1	0	0	1
IPT 211	Physical Training II	0	0	2	0	IHS 222	Principles of Management	2	0	0	2
						IHS 223	Business Communication Skills	1	0	0	1
Total		**17**	**5**	**5**	**23**	**Total**		**19**	**2**	**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	CSE 321	Microprocessors	3	0	3	4
CSE 312	Software Engineering and Project Management	3	0	3	4	CSE 322	Cloud Computing	3	0	3	4
ICS 311	Parallel and Distributed Computing	3	0	3	4	ICS 321	Data Warehousing & Data Mining	3	0	3	4
IEC 311	Digital Signal Processing	3	0	3	4	ICS 322	Machine Learning	3	0	0	3
IMA 311	Soft Computing	3	0	0	3	ISC 321	High Performance &Scientific Computing	3	0	0	3
IHS 311	Human Resource Management	1	0	0	1	IOE 321	Software Design Patterns	3	0	0	3
IHS312	Financial Management & Accounting	1	0	0	1	ICS 323	Honours Project I (Optional) I				
IHS313	Operations and Supply Chain Management	1	0	0	1						
Total		**18**	**0**	**12**	**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**
CSE 411	Computer Graphics	3	0	3	4	ICS 422	Applied Predictive Analytics	3	0	0	3
CSE 412	Big Data Analytics	3	0	3	4	ICS 423	Internet of Things /Industrial Training	3	0	3	4
ICS 412	Cryptography and Network Security	3	0	3	4	IOE 421	Deep Learning	3	0	0	3
IOE 411	Block Chain Technology	3	0	0	3	ICS 421	BTP - II	6	0	0	6
ICS 411	BTP - I	6	0	0	6	ICS 424	Honours Project II (Optional)				
ICS XXX	Research Course(Optional)					ICSXXX	Research Course(Optional)				
Total		**18**	**0**	**9**	**21**	**Total**		**15**	**0**	**3**	**16**
Cumulative Credits at the End of Fourth Year:174(BTech); 174+ 12=186(BTech(Hon)); 174+20= 194(BTech- MS) MMS)											
Semester –IX						**Semester -X**					
Course	**Course Name**	**L**	**T**	**P**	**C**	**Course**	**Course Name**	**L**	**T**	**P**	**C**
ICS 511	Research Project	12	0	0	12	ICS 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(BTech-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) PROGRAMME

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 Elective	3	3	3	Semester V to VIII
8	Engineering Elective	4	4	4	Semester V to VIII
9	Any other Electives/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 VI to VIII
13	Research Project			24	Semester IX to X
Total Credits		174	186	218	
CGPA		5.5	6.0	6.0	

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 computer science courses
- To explain and apply the basic methods of discrete mathematics in Computer Science.
- 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.

ICS 111 IT Workshop I [3-1-3-5]

Course Objectives

To extend student's knowledge in basics of computers and networks. This enables students to understand the internals of systems, which includes hardware parts, software and its installation procedure, basic Linux commands. Students would also be getting familiar with various networking terminologies and its components. They would be also studying to setup and develop a dynamic web application.

Course Outcomes:

- Have a knowledge of the various hardware components.
- Have an understanding of Linux commands and shell scripting.
- Be aware of basic networking concepts, devices and its functionality.
- Be aware of the basic web development scripting languages like HTML, CSS, XML, and JavaScript.

Syllabus

Computer Hardware – Prerequisite, Computing Agents CPU, Memory, Motherboard - Computer Peripherals - I/O devices, Storage devices, Interface cards – Buses – Firmware - Boot process - Writing/formatting media.

Computer System Software - Operating Systems, Unix/Linux commands, Shell

scripting. Computer Communications – LAN, WAN, Client/Server networks, Peer-to-Peer networks, Topologies, Basics of TCP/IP, IP addresses, DNS, Routers, Internet, WWW, FTP, Email servers, Web servers.

Web Design - Basics of HTML, CSS, XML, and JavaScript.

Lab - Practice

Computer Hardware – Familiarization CPU Box, Mother board, CPU & Chip-set, Interface cards, Card slots, Hard disk, Cables, SMPS, NIC, Various ports, etc.

Computer Peripherals - I/O Devices. Storage devices, Interface cards – Buses – Firmware - Boot process - Writing/formatting media.

Computer System Software - Operating Systems, Windows, Linux, Commands

Unix/Linux commands, Shell scripting. Client/Server networks, Peer-to-Peer networks, LAN, WAN, MAN.

Familiarization of - Basics of TCP/IP, IP addresses, DNS, Routers, Internet, WWW, FTP, Email servers, Web servers.

Web Design - Basics of HTML, CSS, XML, Java Scripting

Text Books/References

G. Michael Schneider, Judith Gersting, Invitation to Computer Science, Seventh Edition, 2015.

1. Computer Science Illuminated, Jones & Bartlett Learning; Sixth Edition, 2016.
2. Jennifer Niederst Robbins, Learning Web Design, O'Reilly Fourth Edition, 2012.
3. Ron White, How Computers Work: The Evolution of Technology, Que Publishing; Tenth Edition, 2014.
4. Alan Clements, Principles of Computer Hardware, Oxford University Press India, Fourth Edition, 2013.
5. David Reed,A Balanced Introduction to Computer Science, Pearson, Third Edition, 2010.
6. Peter Norton's Intro to Computers, Peter Norton, McGraw-Hill Higher Education, Sixth Edition, 2005.
7. Steven Holzner, PHP: The Complete Reference, McGraw Hill Education, 2017.
8. Arnold Robbins and Nelson H. F. Beebe, Classic Shell Scripting, O'Reilly Media, 2008.
9. Richard Peterson, Linux: The Complete Reference, McGraw Hill Education Sixth Edition, 2017

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

Course Objectives

To introduce the problem-solving processes/ techniques

- to teach computer programming
- to use C & C++ for solving the problems

Course Outcomes:

Students learn how to write the sequence of operations in solving a problem

- Students learn to translate the problem solving steps to a program
- 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 flow chart, 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 111 Digital Design and Electric Circuits [3-1-3-5]

Course Objectives

The primary objective of this course is to provide the student with the fundamental concepts and skills necessary to analyze and design combinational and sequential logic circuits. The course explains the basics of analog and digital logic circuits. It also introduces the student a hardware description language and its application to the design of combinational, sequential and simple digital systems. The material covered in the lecture is reinforced through practical experience in the associated lab together with the use of Verilog HDL to synthesize logic circuits.

Course Outcomes:

- Understand the fundamentals of analog and digital circuits.
- Analyze and design a circuit of logic gates that have the desired relation between the input and output terminals.
- Understand the logic properties of flip flops .
- Analyze and design counters, registers, and similar circuits.
- Implement combinational and sequential circuits using a hardware description language.

Syllabus

Introduction - Analog and Digital circuits – Kirchhoff's Laws, Superposition Theorem, Thevenin's and Norton's Theorems; 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-DeMorgans theorems, SOP and POS forms. Karnaugh Maps-to simplify Boolean expressions, truth table functions. Combinational Logic-Analyze 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.

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

Course Objectives

The objective of the class was to improve the English communication skills of First Semester B. Tech students who had just passed out of their Senior Secondary classes. This was 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 ex tempore 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 Books/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.Matthew 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. R. 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 Electronic Circuits and Measurements [3-1-3-5]

Course Objectives

- To impart the basic concepts of semiconductor devices
- To make students capable of analyzing the operation of various electronic circuits
- To develop knowledge for designing simple analog circuits using discrete and integrated components.
- To familiarize the students with the construction and working principle of different types of sensors and transducers.
- To give awareness about the measuring instruments and the methods of measurement

Course Outcomes:

- Characterize semiconductor devices like diodes, transistors, FETs and operational

amplifiers
- Apply the knowledge of semiconductor devices to Design and implement basic electronic circuits
- Use concepts in common use for converting a physical parameter into an electrical quantity
- Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like temperature, pressure, flow, acceleration, etc

Syllabus

Diodes: Introduction to diodes, Semiconductor materials, Diode Characteristics, Operation, Diode Applications, Rectifiers, Clipping and Clamping Circuits, Zener Diodes as regulators

Bipolar Junction Transistors (BJTs): Introduction to transistors, Transistor Construction, Operation, NPN and PNP transistors, Transistor Voltages and Currents, Transistor Characteristics. Common base and Common emitter transistor configurations, Biasing BJTs: Fixed bias, Emitter-Bias, Voltage Divider Bias, Emitter Follower bias , Collector Feedback bias, Transistor Amplification, Transistor as a switch

Field Effect Transistors : Introduction, JFET, MOSFET, Characteristics, Depletion Type,

Enhancement type, FET Biasing, Different configurations, Amplification, FET as a switch.

Operational Amplifier (Op-amp): Introduction, Differential amplifier, Ideal Op-amps, parameters, Op-

amp Applications: voltage Adder, Subtractor, Integrator, Differentiator circuits, constant gain multiplier, voltage buffer.

Principles of sensing & transduction, Introduction to Mechanical and Electromechanical sensors, Strain gauge, Inductive sensors, Capacitive sensors, Thermal sensors, Magnetic sensors, Smart Sensors.

Lab Practice

Familiarization of Basic Electronic Lab Equipments, Familiarization of Diodes, Testing. Diode characteristics, Diode Circuits: Rectifiers, Regulators, Clipping and Clamping Circuits.

Familiarization of Transistors, Bipolar Junction Transistor Testing, Characteristics, Biasing,

Amplifiers, Oscillators.

Junction Field Effect Transistor Familiarization, Testing, Characteristics, Biasing, Amplifiers.

Operational Amplifier (Op-amp) Familiarization, Testing, Op-amp circuits, amplifiers, detectors etc.

Text Books/References

1. David A Bell, Electronic Devices and Circuits, Oxford University Press, Fifth Edition, 2008.
2. Sedra A. and Smith K. C, Microelectronic Circuits", Oxford University Press, Sixth Edition, 2011.
3. Robert. L. Boylestad, Louis Nashelsky, Electronic Devices and Circuits Theory, Pearson Education, Eleventh Edition, 2015.
4. Jacob Millman and Christos. C. Halkias, Electronic Devices and Circuits, Mc. Graw Hill, Fourth Edition, 2015.
5. Albert Malvino and David J Bates, Electronic Principles, Seventh Edition, McGraw Hill, 2006.
6. S Franco, Design with Op-Amp and analog integrated circuits, Third Edition, McGraw Hill, 2001.
7. Sensor & transducers, D. Patranabis, 2nd edition, PHI
8. Instrument transducers, H.K.P. Neubert, Oxford University press.
9. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

ICS 121 Data Structures [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
- Analyze simple algorithms, like sorting and searching using mathematical tools, like formulation and solving of recurrences, asymptotic analysis and probabilistic analysis
- Analyze 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, Stack & Queue application.

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

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

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.

ICS122 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. and , Computer Architecture: A Quantitative Approach, Fifth Edition, Morgan Kaufman, 2011.
4. Carl Hamazher, ZvonkoVranesic and SafwatZaky, Computer Organization, Fifth Edition, McGraw Hill, 2002.

ICS 123 IT Workshop II [2-1-3-4]

Course Objectives

- To introduce the object-oriented problem-solving processes/ techniques
- To learn Object oriented programming
- To use JAVA application development platforms and Android application development platform

Course Outcomes:

- Students learn OOP development on Eclipse and developer platform
- Students learn GUI based programming
- Students learn to develop android and mobile applications
- Students learns to write larger complex applications

Syllabus

Introduction to OOPs and Java Language Fundamentals - OOPs Principles, Features of Java. JVM, Bytecode, JRE, Language Fundamentals.

Classes and Objects- Introducing class fundamentals, Object and Object reference, Introducing methods, Extending Objects, Object Life time & Garbage Collection, Creating and Operating Objects, Constructor & initialization code block, Access Control, Modifiers, Nested, Inner Class and Anonymous Classes, Abstract Class and Interfaces, Defining Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, finalize() method, native Method. Use of "this " reference, Use of Modifiers with Classes & Methods, Method overriding, Package and Interfaces, Garbage Collection.

Extending Classes and Inheritance Use and Benefits of Inheritance in OOP, Types of Inheritance in Java, Role of Constructors in inheritance, Overriding Super Class Methods, use of "super", Polymorphism in inheritance, Implementing interfaces.

Package Organizing Classes and Interfaces in Packages, Package as Access Protection.

Exception Handling: Exceptions & Errors, Types of Exception, Control Flow in Exceptions, JVM reaction to Exceptions, Use of try, catch, finally, throw, throws in Exception Handling, Built-in and User Defined Exceptions, Checked and Un-Checked Exceptions.

Array & Strings : Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Operation on String, Mutable & Immutable String, Using Collection Bases Loop for String, Tokenizing a String, Creating Strings using String Buffer

File Input/Output – I/O Operations in Java(java.io Package),Streams and the new I/O Capabilities ,Understanding Streams, The Classes for Input and Output, The Standard Streams, Working with File Object, File I/O Basics, Reading and Writing to Files, Buffer and Buffer Management, Read/Write Operations with File Channel. Collection and Wrapper classes.

Applets- Applet & Application, Applet Architecture, Parameters to Applet, Embedding Applets in Web page.

Introduction to PHP app development- Introduction to PHP, Basic Syntax of PHP, PHP statement terminator and case insensitivity, Embedding PHP in HTML, Comments, Variables, Assigning value to a variable, Constants, Managing Variables; Operators and

Controls Structures; Functions in PHP, Arrays, PHP File and Forms Handling- File Open, File Creation, Writing to files, Reading from File, Searching a record from a file, Closing a File, PHP Server-side programming - Using PHP With HTML Forms, GET and POST methods, Sessions and Cookies, Support for Database, Creating classes in PHP.

Text Books/References

1. C. Thomas Wu, An Introduction to Object Oriented Programming with Java, Fifth Edition, 2009.
2. Ken Arnold, James Gosling and David Holmes, The Java Programming Language, Fourth Edition, 2005.
3. Herbert Schildt, Java: The Complete Reference, McGraw Hill Education(India), 11th Edition 2018.
4. Steven Holzner, PHP: The Complete Reference, McGraw Hill Education, 2017.

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

Course Objectives

- 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:

Understanding 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.

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.

IHS 122 Foreign Language [1-0-0-1]

SEMESTER III

IMA211 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.

ICS 211 Design and Analysis of Algorithms [3-1-0-4]

Course Objectives

- Analyze the asymptotic performance of algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis
- Synthesize efficient algorithms in common engineering design situations.

Course Outcomes

- Argue the correctness of algorithms using inductive proofs and invariants.
- Analyze worst-case running times of algorithms using asymptotic analysis.
- Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
- Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm.

Synthesize dynamic programming algorithms, and analyze them.

- Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize greedy algorithms, and analyze them.
- Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.
- Explain what an approximation algorithm is, and the benefit of using approximation algorithms.

Syllabus

Introduction: Efficiency – Run Time & Space. Analyzing an Algorithm – Insertion Sort- Proof of Correctness – Complexity – Asymptotic Notations

Divide and Conquer: Analyzing Recursive Algorithms – Merge Sort, Recurrence Relations – Binary Search. Solving Divide and Conquer Recurrences – Recursion Tree – Substitution Method – Master Theorem – Applications of the Master Theorem.

Greedy Algorithms: Locally Optimal Solutions – Interval Scheduling – Minimum Spanning Trees

Prim's Algorithm – Locally Modifying Solutions to Build Better Solutions – Exchange Arguments

Dijkstra's Algorithm – Kruskal's Algorithm – Knapsack – Huffman Coding

Dynamic Programming: Reusing work across sub computations – Definition of Dynamic Programming – Optimal Rod Cut Problem - Optimal Matrix Chain Multiplication - Bellman-Ford Algorithm, Floyd-Warshall Algorithm – Longest Common Subsequence – Machine Scheduling Problem.

Amortized Complexity Analysis – Aggregate Method, Accounting Method, Potential Method, Dynamic Tables – Balanced Trees

Intractable Problems: Polynomial Time – class P – Polynomial Time Verifiable Algorithms – class NP – NP completeness and reducibility – NP Hard Problems – NP completeness proofs – Approximation Algorithms

Text Books/References

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein - Introduction to Algorithms, MIT Press, Third Edition, 2010.
2. Jon Kleinberg, Eva Tardos, Algorithm Design ,Pearson Addison, Wesley, 2013.

ICS 212 Operating Systems [3-1-0-4]

Course Objectives

- To introduce the Fundamental concept of OS, and how OS works;
- To study the Building blocks of OS, Components of OS

Course Outcomes:

- Students will be able to design an OS,
- Students will be able to implement various components of OS,
- Students will be able to implement a small OS

Syllabus

Operating system overview: Computer System Organization, Operating System structure, operations of OS, process management, memory management, storage management, protection and security, distributed systems.

Processes: Process concept, Process scheduling, Operations on processes, Cooperating processes, inter-process communication

Threads: Overview, Multi-threading models, threading issues, P threads, Windows XP threads

CPU Scheduling: Basic concepts, scheduling criteria, scheduling algorithms, multiple-processor scheduling

Process synchronization: The critical section problem, Peterson's solution, synchronization hardware, Semaphores, Monitors. Synchronization examples

Deadlocks: Methods for handling deadlocks, Deadlock prevention, deadlock avoidance, Deadlock recovery

Memory management: Swapping, Paging, Segmentation, Virtual memory, Demand paging, Page replacement

I/O Systems: I/O hardware, Application I/O interface, Kernel I/O subsystem, transforming I/O requests to hardware operations

Text Books/References

1. William Stallings,Operating systems: Internals & design principles, Pearson, Seventh edition, 2014.
2. Andrew S. Tanenbaum, Modern Operating Systems, Pearson Fourth Edition, 2016.
3. Charles Crowley, Operating Systems - Design Oriented Approach, Mc. Graw Hill Education, First edition, 2017.
4. Abraham Silberschatz, Galvin, Gagne Operating System Concepts, Wiley, Ninth Edition, 2016.

ICS 213 Database Management System [2-1-3-4]

Course Objectives

- To understand the need for a database and its management using DBMS
- To model Entity-Relationship (ER) diagram for a real-world scenario
- To write relational algebra and relational calculus queries for data handling and retrieval, Write SQL queries for database creation and analysis
- Design efficient database systems using the principle of normalization
- Understand the basics of database transactions, deadlock handling and security.
- How to implement database indexing
- Usage of tools like RA Interpreter and MySQL for executing various queries

Course Outcomes:

- Understand database concepts and structures and query language
- Understand the E R model and relational model
- Apply various Normalization techniques
- Understand query processing and techniques involved in query optimization.

Syllabus

Database Modeling: Database System concepts and architecture, Data modeling using Entity Relationship (ER) model and Enhanced ER model, Specialization, Generalization.

Database Indexing: Data Storage and indexing- Single level and multi-level indexing, Dynamic Multi level indexing using B Trees and B+ Trees

Relational Databases: The Relational Model, Relational database design using ER to relational mapping Relational algebra, Relational calculus, Tuple Relational Calculus, Domain Relational Calculus, SQL

Database Design: Database design theory and methodology, Functional dependencies and normalization of relations, Normal Forms, Properties of relational decomposition, Algorithms for relational database schema design

Database Transactions: Transaction processing concepts, Schedules and serializability, Concurrency control, Two Phase Locking Techniques, Optimistic Concurrency Control, Database recovery concepts and techniques

Database Security: Introduction to database security

Text Books/References

1. Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, Fifth Edition, Pearson Education, 2008.
2. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, Third Edition, McGraw Hill, 2014.
3. Peter Rob and Carlos Coronel, Database System- Design, Implementation and Management, Seventh Edition, Cengage Learning, 2007.

ICS 214 IT Workshop III [2-1-3-4]

Course Objectives

- Learn Python scripting and the scripting shell.
- Master the basics of programming constructs, like conditions, loops, functions, etc.
- Introduce sequence types in Python like Lists, Tuples, Sets and Dictionaries
- Be exposed to advanced applications such as databases, networks, etc

Course Outcomes:

- Write python programs for various applications
- Write Database programs to create, access, modify and update data
- Write network programs for sending emails, ftp, sockets etc

Syllabus

Introduction to data types, variables, constants, operators, input-output, basic formatting, running python programs, date and time functions

Conditionals, if statement and variants, relational operators, logical operators

Iteration and while loops, for loops and range

command, random numbers

File processing, reading and writing files, parsing files, text files and CSV files

Lists and list processing, list operations, list traversals, tables as lists

Tuples, Maps, Sets and Dictionaries, creation and traversals

Strings and string processing, string functions, conversions

User defined Functions, lambda functions, recursive functions, built-in functions, yield statement, parameter passing

Classes and object-oriented programming, inheritance, associations

Database processing, creating tables, querying, MySQL and PySqlite

Network programming, sockets, email sending, ftp Threads and multithreading

Numpy and applications in matrices, random numbers Scipy, Matplotlib, graphing and charting data

Introduction to Android app development

Text Books/ References

1. Ljubomir Perkovic, Introduction to Computing with Python, Wiley, Second Edition, 2015.
2. Narasimha Karumanchi, Data Structures and Algorithms With Python, Careermonk Publications, 2015.

ISC 211 Introduction to Bioinformatics [3-0-0-3]

SEMESTER IV

ICS 221 Theory of Computation [3-1-0-4]

Course Objectives

- Course will provide a formal connection between algorithmic problem solving and the theory of languages and automata and develop them into a mathematical (and less magical) view towards algorithmic design and in general computation itself.
- The course should in addition clarify the practical view towards the applications of these ideas in the engineering part of CS.

Course Outcomes:

- Model, compare and analyse different computational models using combinatorial methods.
- Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
- Construct algorithms for different problems and argue formally about correctness on different restricted machine models of computation.
- Identify limitations of some computational models and possible methods of proving them.
- Have an overview of how the theoretical study in this course is applicable to and engineering application like designing the compilers.

Syllabus

Introduction: Notion of formal language- Strings, Alphabet, Language, Operations, Finite State Machine, definitions, finite automaton model, acceptance of strings and languages, deterministic finite automaton, equivalence between NFA and DFA, Conversion of NFA into DFA, minimization of FSM ,equivalence between two FSM's, Moore and Mealy machines.

Regular expressions: Regular sets, regular expressions, identity rules, manipulation of regular expressions, equivalence between RE and FA, inter conversion, Pumping lemma, Closure properties of regular sets regular grammars, right linear and left linear grammars equivalence between regular linear grammar and FA, inter conversion between RE and RG.

Context free grammars: Derivation, parse trees. Language generated by a CFG. Eliminating useless symbols, -productions, and unit productions. Chomsky Normal Form. Pushdown automata: Definition, instantaneous description as a snapshot of PDA computation, notion of acceptance for PDAs.

Turing machine: Turing machine, definition, model, design of TM, Computable Functions, recursive enumerable language, Church's Hypothesis, Counter machine, types of TM's, RAM machine

Un-decidability and classes of problems: Chomsky hierarchy of languages, linear bounded automata and context sensitive language, Grammar, decidability of problems, Universal Turing Machine, un-decidability of post's correspondence problem. Turing reducibility logical theories Complexity classes: P, NP, co-NP, EXP, PSPACE, L, NL, ATIME, BPP, RP, ZPP, IP.

Text Books/ References

1. M Sipser, Introduction to the Theory of Computation, Second Edition, Thomson, 2005.
2. Lewis H.P. and Papadimition C.H. Elements of Theory of Computation, Prentice Hall of India, Fourth Edition, 2007.
3. S. Arora and B. Barak, Computational Complexity: A Modern Approach, Cambridge University Press, 2009.
4. C. H. Papadimitriou, Computational Complexity, Addison-Wesley Publishing Company, 1994.
5. D. C. Kozen, Theory of Computation, Springer, 2006.
6. D. S. Garey and G. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, New York, 1979.
7. J Hopcroft, JD Ullman and R Motwani, Introduction to Automata Theory, Languages and Computation, Third Edition, Pearson, 2008.

ICS 222 Object Oriented Analysis and Design [3-0-3-4]

Objectives

- To understand the Object-based view of Systems
- To develop robust object-based models for Systems
- To inculcate necessary skills to handle complexity in software design

Course Outcomes:

- Ability to analyze and model software specifications.
- Ability to abstract object-based views for generic software systems.

- Ability to deliver robust software components.

Syllabus

Introduction to Systems Concepts: Definition. Characteristics of a System: Organization, Interaction, Interdependence, Integration. Elements of a System: Inputs and Outputs, Processor(s), Control, Feedback, Environment. Types of Systems: Physical/Abstract Systems, Open/Closed Systems, Man-made Information Systems. System Modelling: The importance of Modelling, Principles of Modelling, Object-Oriented Modelling, Introduction to UML. Best Practices of Software Engineering: Develop Iteratively, Models and visualization, UML, Software Development Life Cycle. Rational Unified Process: Process, Phases in RUP, RUP Workflows Process, Lifecycle.

Concepts of Object Orientation: Object Modelling Technology, Basic Principles of Object Orientation: Abstraction Encapsulation, Polymorphism, Modularity, Hierarchy. UML Modeling Mechanisms. Structural Modelling: Classes and Interfaces, Attributes and Operations, Relationships: Association, Dependency, Generalization, Multiplicity, Aggregation, Interface, Types and Roles, Instances. UML Notation: Things, Relationships, Extensibility, Diagrams. UML Standard Elements: Stereotypes, Tagged Values, Constraints.

Structural Diagrams: Class Diagrams, Object Diagrams. Designing an object-oriented system: Identifying the classes, assigning attributes and behaviour, finding relationship between classes, arranging classes into hierarchies: A design example. Requirement Overview: Software Requirement Specification, Use case Model, Use case Diagrams. Analysis and Design: Use case Analysis, Use case behaviour, Finding Classes, Class Analysis, Attributes and Associations

Interaction Diagrams: Sequence Diagrams, Collaboration Diagrams, Activity Diagrams: Activity States, Transitions, State Chart Diagram. Component Diagrams, Deployment Diagrams: Distribution Diagrams, Runtime Architecture, Concurrency, Process, Nodes, Networks, Deployment Model.

Textbooks/ Reference

1. Grady Booch James Rumbaugh, Ivar Jacobson, The Unified Modeling Language User Guide, Addison Wesley, 2012.
2. Grady Booch, Object Oriented Analysis and Design With Applications, Third Edition, Pearson Education, 2009.
3. Michael Blaha, James Rumbaugh, Object Oriented Modeling and Design with UML, Second Edition, Pearson Education, 2005.
4. Martin Fowler, UML Distilled: A Brief Guide to Standard Object Modeling, Third Edition, Addison Wesley, 2015.
5. Brett D. McLaughlin, Gary Pollice, and Dave West,Head First Object-Oriented Analysis and Design, First Edition, O'Reilly, 2006.
6. Elias M Awad, System Analysis and Design, Second Edition, Galgottia Publications Pvt. Ltd, 2015.

ICS 223 Compiler Design [3-0-3-4]

Course Objectives:

- The main outcome of the course 'Compiler Design' is to make the students capable of applying the principles, algorithm, and data structures involved in the design of compilers.
- Students should be able to design a lexical analyser in lex according to the specification. They should be able to design a parser in yacc when the specification is mentioned. They should be able to construct a compiler according to the rules and constrains given.

Course Outcomes

- To introduce the major concept areas of language translation and compiler design.
- To enrich the knowledge in various phases of compiler and the design issues involved in compilation, code optimization techniques, machine code generation, and use of symbol table.
- To extend the knowledge of parser by parsing LL parser and LR parser. 4. To provide practical programming skills necessary for constructing a compiler.

Syllabus

Introduction to programming language translation. Lexical analysis: Specification and recognition of tokens.

Syntax analysis: Top-down parsing-Recursive descent and Predictive Parsers. Bottom-up ParsingLR (0), SLR, and LR (1) Parsers.

Semantic analysis: Type expression, type systems, symbol tables and type checking. Intermediate code generation: Intermediate languages. Intermediate representation-Three address code and quadruples. Syntax-directed

translation of declarations, assignments statements, conditional constructs and looping constructs.
Runtime Environments: Storage organization, activation records. Introduction to machine code generation and code optimizations.

Lab Practice
Generation of lexical analyzer using tools such as LEX - Generation of parser using tools such as YACC - Creation of Abstract Syntax Tree-Creation of Symbol tables, Semantic Analysis - Generation of target code.

Text Books/References

1. Aho A.V., Lam M. S., Sethi R., and Ullman J. D., Compilers: Principles, Techniques and Tools, Pearson Education, 2007.
2. Appel A.W, and Palsberg J., Modern Compiler Implementation in Java, Cambridge University Press, 2002.
3. W. Appel, Modern Compiler Implementation in C, Cambridge University Press, 1998.
4. V. Aho, M. S. Lam, R. Sethi, J. D. Ullman, Compilers- Principles, Techniques & Tools, Second Edition, Pearson Education, 2007.

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.

Texts 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. W. 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 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.

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 [2-0-0-2]

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 ResponsibilityControl:- 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.

IHS 223 Business Communication Skills [1-0-0-1]

Course Objective

- To give students a comprehensive view of communication, its scope and importance in business, and the role of communication in establishing a favourable outside the firm environment, as well as an effective internal communications program.
- To build an understanding of different organizational cultures, business practices, and social norms to communicate more effectively in domestic and cross-cultural business contexts.
- To develop an awareness of the importance of concise written expression to modern business communication and utilize electronic presentation software.

Course Outcome

- It will provide an overview of Prerequisites to Business Communication
- It will provide an outline to effective Organizational Communication

Syllabus

The Concept and Significance of Managerial Communication- Internal Communication and External Communication - Objectives of Managerial Communication -Effective Communication Skills -7C's and 4 S's (Shortness , simplicity, strength sincerity) - Communication Environment and Communication Process
External, Organizational and Personal Factors - Making Communication Effective

Letters for different occasions- accepting/declining invitations, congratulating, consoling, conveying information – Social Communication - Blogs, Reviews (films, books), posting comments, tweets, cross-cultural communication. Work Place Communication – Minutes, Proposals, Memorandums, Press releases, Presentations, Profile of institutions, Speeches, Responding to enquiries and complaints, Resumes, Applications. Commercial/Business Letters and Principles of Effective Writing - Sample Letters.

Introduction - Public Speaking Skills - Role of audio visual aids and computers in oral presentations - Tele Conference - Video Conference. Interviewing– Placement Interviews, Discipline Interviews, Appraisal - Interviews and Exit Interviews. Listening skills -Mannerisms -Body language– Kinesics – Professional Dressing – Conducting meetings, seminars and conferences - Group discussion

Introduction - Phases of a Negotiation - Characteristics of Negotiation - Opening Negotiations - Legal Aspects of Communication – Reports: Writing reports of different kinds –Long & short reports -Formal & Informal reports Annual report, Status report, Survey report.

TextBooks/References

1. Courtland L. Bovee ,John V Thill, Business Communication Today, Prentice Hall International

2. Raymond V Lesikaret. al., Connecting in a Digital World, 13e,Tata McGraw Hill, New Delhi.
3. 3 .Guffey Mary Ellen, Business Communication, South-Western Collage publishing
4. Meenakshi Raman, Sangeetha Sharma, Technical Communication- Principles and Practice, Oxford
5. Argenti Paul A, Irwin, Corporate Communication, McGraw Hill.
6. Atkinson, Reynolds, Business Writing & Procedures, American Book Co.

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 312 Software Engineering and Project Management [3-0-3-4]

Course Objectives

The objective of this course is to prepare the students for successful careers in software engineering or related domain through a thorough study of software engineering principles.

Course Outcomes:

- Acquire a thorough knowledge of the fundamental concepts in software engineering.
- Learn the actual need for software engineering and various software development life cycle models which will be helpful in software development process.
- Study various approaches in software design and the major techniques in system testing for better software development process.

Syllabus

Introduction to software engineering: Scope and necessity of software engineering-Evolution of software design techniques-Recent challenges in software industry

Software life cycle model: Need for software life cycle model-Different life cycle models-Waterfall model-Iterative waterfall model-Prototyping model-Evolutionary model-Spiral

model-Agile development methodologies-Rational unified process (RUP)- Extreme Programming (XP)

Requirement analysis and specification: Requirements engineering-Types of system requirements-Role of system analyst-Software requirement specification-Formal requirement specification

System Design: System modeling- Unified modeling language (UML)-Design Challenges-Design Practices- Top-down and bottom-up design- Experimental prototyping-Collaborative design

Basic concepts in user interface design: Characteristics of a user interface-Types of user interfaces-Component based graphical user interface design

Software testing: Role of testing-Testing strategies-Unit tests-Integration testing-Top down integration-Bottom up integration-Validation testing-Alpha testing-Beta testing-Other forms of high-level testing-Stress testing-Code inspections-Manual testing-Automated testing-Breaking tests-Regression testing-Examples of testing frame works (Tinderbox, JUnit)

Software Project Management: Cost estimation-Project scheduling- Staffing-Software configuration management-Quality assurance-Software quality models-Project Monitoring-Risk management, etc.

Emerging Trends in Software Engineering: Observing software engineering trends-Identifying "Soft trends"-Technology directions-Tools related trends

Text Books /References

1. Roger S Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, 7th Edition.
2. Ian Sommerville, Software Engineering, Pearson Education, 9th Edition.

ICS 311 PARALLEL AND DISTRIBUTED COMPUTING [3-0-3-4]

Prerequisites

- Computer Networks
- Fundaments of Programming
- Computer Organization

Course Objectives

- To introduce the concept and the basics of parallel and distributed computing,
- To provide knowledge on various available parallel programming models
- To enable awareness on the utilization of programming models on various scientific applications

Course Outcomes:

- The students will have knowledge on various programming languages for HPC applications.
- The students will have sufficient practical knowledge to utilize the performance analysis tools,
- The students will know the applications of parallel and distributed computing models.

Syllabus

Architectures – Multi-core and Many-core architectures, Accelerators (SIMD untis - Vectorization, GPUs), Goals of parallel systems.

Applications – Scientific applications, Characteristics, requirements, regular grid applications, irregular applications, data dependence, parallelization process.

Parallel Programming on Shared Memory – OpenMP (C++ languages), Execution Model, Shared and private data, Directives, Barriers, Sections, Run-Time library functions, scheduling strategies, Scalability study, OpenMP for accelerator programming.

Parallel Programming on Distributed Memory – MPI, Collective operations, Non-Blocking, Collectives, Process topologies, Parallel I/O, Single sided communications.

Performance Tools – Concepts, Event-Model execution, profiling, tracing, types of profiling, profiling tools – Scalasca, Score-P, MPI-P, EnergyAnalyzer, Tracing tools, Autotuning – Periscope Tuning Framework.

Text Book / References

1) Ian Foster: Designing and Building Parallel Programs – Concepts and tools for Parallel Software Engineering, Pearson Publisher, 1st Edition, 2019.
2) Using OpenMP – The Next Step Using OpenMP – The Next Step – by Ruud van der Pas, Eric Stotzer and Christian Terboven (2017)
3) Using OpenMP – The Next Step – by Ruud van der Pas, Eric Stotzer and Christian Terboven (2017)

4) Parallel Programming in C with MPI and OpenMP by Michael J.Quinn
5) The International Journal of Parallel Programming – Issues and articles devoted to OpenMP, MPI, CUDA.

IEC 311 Digital Signal Processing [3-0-3-4]

Course Objectives

- To understand the key theoretical principles underlying DSP
- To analyze and implement digital signal processing systems in time domain.
- To sample and reconstruct analog signals.
- To analyze digital signal processing systems using DTFT and Z transform.
- To design FIR and IIR filters to meet specific magnitude and phase requirements
- To learn how to use a powerful general-purpose mathematical tool such as MATLAB to design and simulate DSP systems.
- To understand the architecture of a digital signal processor and some programming issues in fixed-point digital signal processor in real-time implementation.
- To design real-time signal processing algorithms using a DSP processor

Course Outcomes:

After successful completion of this course, student will be able to:

- Explain the basic concepts of signal processing
- Characterise signals and systems in discrete time, including use of the z-transform
- Use Fourier transform and convolution to filter signals
- Design FIR and IIR filters to satisfy a desired frequency response;
- Explain the role of the window function and describe its influence on FIR filters
- Design IIR filters on the basis of an analogue design
- Use MATLAB for DSP system analysis and design.
- Design and evaluate a real-time DSP systems

Syllabus

Introduction**,** signals, systems, examples, classification of signals, basic operations on signals; folding, shifting, time scaling classification of systems, linear and nonlinear, time variant and invariant, causal and noncausal, stable and unstable systems

DSP Advantages and disadvantages; Quantisation and sampling; Aliasing; Anti-aliasing and reconstruction filters

Time domain analysis of discrete signals and systems: Impulse response, Linear Time Invariant (LTI) systems, Convolution sum

Frequency domain analysis of systems using Fourier transform

Difference equations and z transforms

Finite and infinite impulse response filters, FIR and IIR, Poles, zeros and frequency response.

Design of Digital Filters

Design of nonrecursive and recursive digital filters

Hardware & software implementations

Some Typical DSP Applications Speech recognition; Control; Image recognition; Radar; Room response analysis,signal compression

DSP Hardware: A/Ds, D/As and over-sampling

Microprocessors; DSP processors; Fixed and floating point comparisons

Programming and debugging techniques

List of Experiments

1. Verification of sampling theorem.
2. Linear and circular convolution of sequences
3. Auto and cross correlation of sequences
4. Solving a difference equation.
5. Computation of N point DFT of a sequence, plot magnitude and Phase spectrum
6. DFT computation of square pulse and Sinc function etc.
7. Design and implementation of FIR filter to meet given specifications (using different window techniques).
8. Design and implementation of IIR filter to meet given specifications.
9. Introduction to Code Composer Studio-I
10. Introduction to the Addressing Modes
11. Audio Codec and its Applications
12. Real Time Data Exchange

Textbooks/References

1. Proakis John G and Manolakis Dimitris G, Digital Signal Processing: Principles, Algorithms and Applications, 4th Edition, Prentice-Hall, 2006
2. Oppenheim Alan V, Schafer Ronald W and Buck John R, Discrete Time Signal

Processing, 3rd Edition, Pearson Education, 2009.
3. Prandoni Paolo and Vetterli Martin, Signal Processing for Communication, 1st Edition, EPFL Press.
4. Mitra Sanjit K, Digital Signal Processing : A Computer Based Approach, 4th Edition, McGraw Hill, 2011.
5. Kuo Sen M, Lee Bob H andTian Wenshun, Real-Time Digital Signal Processing: Implementations and Applications, 2nd Edition, John Wiley, 2006.
6. Lapsley Phil, DSP Processor Fundamentals: Architectures and Features, IEEE Press, 1997
7. Ackenhusen John G, Real Time Signal Processing: Design and Implementation of Signal Processing Systems, Prentice-Hall,1999.

IMA 311 Soft Computing [3-0-0-3]

Course Objectives

- To summarize basic learning laws and architectures of neural networks.
- To describe supervised and unsupervised learning laws of Neural Networks.
- To introduce Fuzzy Logic, Fuzzy relations and Fuzzy mathematics for designing a Fuzzy logic controller.
- To discuss neuro fuzzy approaches like ANFIS and CANFIS.

Course Outcomes:

At the end of the course the student should be able to

- To translate biological motivations into various characteristics of neural networks
- To comprehend and analyse basic leaning laws of neural networks and activation functions used.
- To interpret associative memories for storing and recalling the input patterns
- To learn and implement supervised and unsupervised learning law for various applications.
- To decide on fuzzification and De-fuzzification methods for Fuzzy inference systems
- To apply and integrate various neuro-fuzzy techniques for designing intelligent systems using ANFIS and CANFIS.
- To design a model using neural networks and fuzzy logic for various applications

Syllabus

Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models – important technologies – applications. Fuzzy logic: Introduction – crisp sets- fuzzy sets – crisp relations and fuzzy relations: cartesian product of relation – classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Genetic algorithm-Introduction – biological background – traditional optimization and search techniques – Genetic basic concepts.

Neural Networks

McCulloch-Pitts neuron – linear separability – Hebb network – supervised learning network: perceptron networks – adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonen Self Organizing Feature Maps, LVQ – CP networks, ART network.

Fuzzy Logic

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

Neuro-Fuzzy Modelling Adaptive Neuro-Fuzzy Inference Systems (ANFIS) - Introduction, Architecture, Hybrid learning algorithm, ANFIS as a universal approximator. Applications – Printed Character Recognition, Inverse Kinematics Problem, Automobile LPG prediction.

Text Books/ References Books

1. S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
2. S.N.Sivanandam , S.N.Deepa, “Principles of Soft Computing”, Wiley India Pvt. Ltd., Paperback, 2018.
3. S.Rajasekaran, G.A.Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic

Algorithm, Synthesis and Applications“, PHI Learning Pvt. Ltd., 2017.
4. Kwang H.Lee, First course on Fuzzy Theory and Applications, Springer, 2005.
5. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications, Prentice Hall, Paperback – 2015.
6. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Addison Wesley, 2003.

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

Course Objective:

- To provide participants a synthesized framework of Human Resources theory & Practice
- To impart fundamentals of HR Practices in Organizations
- Learn to align HR systems with the strategic business objectives of a firm.

Course Outcome

- Students will become familiar with the fundamentals of HR
- It will equip them the tools and techniques of modern Human Resources Management

Syllabus

Introduction to Human Resource Management-Importance-Scope and Objectives. Evolution. Line and Staff aspects of HRM, Line managers; Duties of Human Resources Managers-Human capital management.

Job Analysis

Job analysis: Methods for collecting Job Analysis Information,. Human Resource Planning and Recruiting: The Recruitment and Selection process- Planning and Forecasting, Internal and External sources of candidates, Writing Job Description& Job Specification, Managing HR in challenging times- Testing and Selection: Basic testing concepts, Types of Tests. Interview: Process and Types, Guidelines for Interviews.

Training & Performance Management

Orientation, Training Process, Training Needs Analysis, Training Techniques- On -the-Job & Off-the -Job Training Methods, OJT Process, Training Evaluation. Management Development Programs: Case Study and other Modern Training Methods. Performance Management & Appraisal: Process and Techniques. Career Planning and Management Concepts.

Compensation

Establishing Pay Rates: Steps, Job Evaluation – Wage and Salary administration- Steps and factors affecting, Incentives Benefits and services: Statutory Benefits - Non-statutory Benefits - Insurance Benefits -Retirement Benefits, Flexible Benefits Programs. ESOPs, QWL.

Industrial Relations & Trends in HR

Industrial relations: Significance, Objectives, Approaches. Industrial Disputes- Causes, Forms,

Preventive Machinery. Collective Bargaining: Basic Concepts. Long term settlements: Cases in India. Trade unions: Definition, Objectives, Functions Social Security in India, Employee welfare, Grievance Handling and Discipline-Sources and forms of Grievances -Grievance Procedure, Disciplinary Procedure. Participative Decision making process – Role of quality circle in TQM. Strategic Human Resources Management, Strategic HRM tools. An over view of HR Analytics

IHS 312 Financial Management And Accounting [1-0-0-1]

Course Objective:

- To familiarize participants with fundamentals of Financial Management in an Organization
- To provide the participants various techniques in Financial Management
- To give an overview of the emerging financial issues facing an Organization

Course Outcome

- Students will become familiar with accounting standards and financial management
- It will equip the skills for better financial management

Syllabus

Introduction to Finance

Introduction to Financial management: Business Finance- Concept, types and scope. Financial management: objectives, functions and scope - Interface of financial management with other

functional areas. Role of finance manager- Financial forecasting - Financial planning. Risk and Return concept: – Relationship between risk and return – Risk Diversification.

Time Value of Money & Investment Decisions

Time Value of money and Investment Decisions- Process of compounding – Process of discounting - Future value of Single cash flow and annuity - Present value of a single cash flow and annuity. Investment Decisions: - Capital budgeting – Process of capital budgeting - selection of projects - Estimation of cash flows - Payback and Discounted payback period - Accounting rate of return- NPV – IRR – Capital Budgeting decisions under risk - Capital Rationing - Project selection under rationing.

Finance Decisions

Financing and Capital Structure Decision: Sources of Finance: External and Internal financing. Cost of different sources of capital – Weighted average cost of capital (WACC) and Marginal cost of capital. Capital structure decisions – meaning and pattern– Theories of capital structure- Net income approach - Net operating income approach- Traditional approach-MM approach - Optimum capital structure. Leverage - operating, financial and composite leverage.

Dividend Decisions

Dividend Decisions: Dividend policy – dividend and its forms – objectives of dividend policy– relevance and irrelevance. Theories of dividend decisions: Walter's Approach – Gordon's Approach – MM Approach

Working Capital

Management of Working capital: Meaning and Need of Working capital - factors affecting composition of working capital – Inter dependence among components of working capital – Estimation of working capital – Cash management- Cash flow statement and fund flow statement- Receivables management.

Texbooks/References

1. Brealey, Richard A and Stewart CMyers. Principles of Corporate Finance. McGraw Hill India, 2012.
2. Chandra Prasanna, Financial Management- Theory & Practice, Tata McGraw Hill, 2014..
3. James C Vanhorne, John M WachowiczJr, Fundamentals of Financial Management, Pearson Education Limited, New Delhi.
4. Lawerence J Gitman, Principles of Managerial Finance, Pearson Education limited. New Delhi.
5. Pandey IM, Financial Management. Vikas Publishing House, 2009.
6. Reddy, G Sudarsana, Financial Management, Himalaya Publishing House, 2011.
7. Van Horne James, Financial Management Policy, Prentice Hall India

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

Course Objective:

- To gain a working understanding of logistics principles and to expose students to the basic concepts the language of logistics and supply chain management.
- To refine applied data analysis skills by analyzing and using supply chain data to evaluate supply chain performance and to make business decisions
- To understand current challenges faced by supply chain professionals and to provide a basis for thinking through these challenges

Course Outcome

- Students will become familiar with basic concepts of Supplychain Management
- Students will get a better understanding on web based and electronic applications of supplychain management.

Syllabus

Introduction to Production &Operations Function

Introduction to Production and Operations Functions – Scope of Production and Operations Management – Interaction of Operations Management with other functional areas of Management – Manufacturing and Non Manufacturing operations and their Classifications – Operations Strategy: Elements of Operations Strategy – 5Ps of Operations.

Production & Operations Planning, Manufacturing System, Layout

Production & Operations Planning and Control, Role of Production Planning & Control in Operations Management – Plant Location & Layout: Steps in location selection – Factors influencing Layout – Principles of Layout - Layouts by Products and Process – Hybrid Layout –Design of Operations Systems: Aggregate planning and Master Scheduling, MRP, CRP. Line Balancing & Sequencing – Capacity Planning

Materials Management & Vendor Management

Material Handling: Material Handling Principles – Types – Selection & Design of Material Handling System. Materials Management – Functions – Material planning and Budgeting – Value Analysis – Purchase functions and Procedure - Inventory control – Types of Inventory – Safety stock – Inventory Control Systems – Economic Order Quantity (EOQ) – Perpetual – Periodic – Just In Time (JIT) – Managing Vendors; Vendor Analysis, Rating and Selection – Procedure and Criterions.

Work Study & Maintenance

Work study, Time and Method study: Definition – Importance – Aims and Procedures – Implications on Productivity – Work measurement – Work sampling – Work environment – Industrial safety – Value analysis. Basics of Maintenance Management – Maintenance Decisions

Supply Chain Management & Lean Systems

Supply Chain Management –Concept of Supply chain, Stages and flows in Supply chain, Terminology in Supply chain management – Supply chain disruption- Bull Whip effect. Lean Systems – Basic understanding about Lean concepts- Pull and Push systems, Jidoka, Poke-Yoke, 5S, Total Preventive Maintenance (TPM), Toyota Production System, Kanban System.

TextBooks/References

1. Lee J. Krajewski et al, Operations Management, Process and Supply chains. 11th Edition Pearson India Education Services Ltd. India

2. Russel& Taylor, Wiley, Management, Quality and Competitiveness in a Global Environment, Fifth Edition, India Edition

3. BuffaSarin, Wiley, Modern Production and Operations Management, India Edition

4. KanishkaBedi, Production and Operations Management, Oxford University Press.

5. Aswathappa K and ShridharaBhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.

6. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

7. Mahadevan B, Operations Management Theory and Practice, Pearson Education, 2007.

Semester VI

CSE 321 MICROPROCESSORS [3-0-3-4]

Pre –requisites: Digital Design and Electric Circuits

Course Objectives

- Familiarize the importance and applications of microprocessors and microcontrollers
- Expose architecture of 8085, 8086 and ARM microprocessors
- Impart design and coding knowledge on 8085, 8086 and ARM family.
- Provide practical exposure to students on interfacing various peripheral devices with 8085, 8086 and ARM like LCD, DC motor, Stepper motor, ADC/DAC and many other devices.

Course Outcomes:

After successful completion of this course, student will be able to:

- Design and develop assembly language code to solve problems
- Gain the knowledge for interfacing various devices to 8085, x86 family and ARM processor
- Demonstrate design of interrupt routines for interfacing devices
- Know functioning of hardware devices and interfacing them to x86 family
- Choose processors for various kinds of applications.

Syllabus

Introduction to 8085 microprocessor, architecture, memory, I/O devices, generation of control signals for external operation, assembly language programming of 8085, addressing modes, assembler directives, macros, Interfacing with 8085, Interfacing concepts, Memory Interfacing, Interrupts, Interfacing with peripheral ICs like 8251, 8255, 8253, 8279 etc. Interfacing with ADCs and DACs.

8086 architecture, addressing modes, machine language instruction formats, instruction set, using assembly language with 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.

ARM Embedded systems, RISC design philosophy, Technology and applications of ARM, Architecture of ARM Cortex M3, introduction to programming model, ARM Cortex M3 Instruction Set, Assembly and C language Programming, Keil Development software, Debugging support, memory organization, concept of stack, interrupts, timing, processor modes, simple programming exercises.

List of Experiments

PART-A

1) Design and develop an assembly language program to search a key element “X” in a list of ‘n’ 16-bit numbers. Adopt Binary search algorithm in your program for searching.
2) Design and develop an assembly program to sort a given set of ‘n’ 16-bit numbers in ascending order. Adopt Bubble Sort algorithm to sort given elements.
3) Develop an assembly language program to reverse a given string and verify whether it is a palindrome or not. Display the appropriate message.
4) Design and develop an assembly language program to read the current time and Date from the system and display it in the standard format on the screen.
5) To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations (Demonstrate with the help of a suitable program).
6) To write and simulate C Programs for ARM microprocessor using KEIL (Demonstrate with the help of a suitable program)

PART-B

7) Develop an assembly language program to display messages “ ABCD” and “ 1234” alternately with flickering effects on a 7-segment display interface for a suitable period of time. Ensure a flashing rate that makes it easy to read both the messages (Examiner does not specify these delay values nor is it necessary for the student to compute these values)
8) Design and develop an assembly program to drive a Stepper Motor interface and rotate the motor in specified direction (clockwise or counter-clockwise) by N steps (Direction and N are specified by the examiner). Introduce suitable delay between successive steps. (Any arbitrary value for the delay may be assumed by the student).
9) Design and develop an assembly language program to Generate the Sine Wave using DAC

interface (The output of the DAC is to be displayed on the CRO).
10) To interface LCD with ARM processor. Write and execute programs in C language for displaying text messages and numbers in LCD
11) To interface stepper motor with ARM processor, write a program to rotate stepper motor.

Textbooks/References

1. Ramesh S Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Penram International 5/e, 2013
2. A. K Ray and K. M. Bhurchandi, "Advanced Microprocessors and Peripherals", TMH, 3rd edition 2012.
3. Joseph Yiu, "The definitive guide to the ARM cortex-M3", 2nd edition, Newnes(Elsevier), 2010.
4. Douglas v Hall, SSSP Rao, "Microprocessor and Interfacing", 3rd edition, Tata Mc Graw Hill, 2012.
5. Kenneth J Ayala, "The 8086 Microprocessor programming and Interfacing the PC" Cengage Learning, 2011.
6. Lyla B das, "Microprocessors and Microcontrollers", Pearson education India, 2nd edition, 2014
7. John Ufferbeck, "Microcomputers and Microprocessors: The 8080, 8085, and Z-80 Programming, Interfacing, and Troubleshooting", Pearson, 3/e, 2002
8. W.A. Smith, "ARM Microcontroller Interfacing: Hardware and Software, Eketor, 2010.
9. Steve Furber, "ARM System Architecture", Edison Wesley Longman, 1996.
10. William Hohl, "ARM Assembly Language-Fundamentals and Techniques ", CRC Press, 2009

CSE 322 CLOUD COMPUTING [3-0-3-4]

Prerequisites

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

- Computer Networks
- Parallel and Distributed Computing
- Fundaments of Programming

Course Objectives

The main objectives of this course are listed as follows:

- 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 main Course Outcomes: of this course are listed as follows:

- the students will learn the base 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.

ICS 321 DATA WAREHOUSING AND DATA MINING [3-0-3-4]

Course Objectives

- To introduce the basic concepts of Data Warehouse and Data Mining techniques.
- Examine the types of the data to be mined and apply pre-processing methods on raw data.
- Apply basic classification, clustering and outlier analysis on a set of data.

Course Outcomes:

- Create a data warehouse and process raw data to make it suitable for various data mining algorithms.
- Discover and measure interesting patterns from different kinds of databases.
- Apply the techniques of clustering, classification, association finding, feature selection and visualization to real world data.

Syllabus

Overview of Knowledge extraction, Data Warehousing concepts and Architecture, Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Representation, Data cube technologies, Business Intelligence.

Data Mining: - Data Mining Functionalities – Data Pre-processing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation. Association Rule Mining.

Classification and Prediction:-Issues Regarding Classification and Prediction – Classification

by Decision Tree. Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods.

Cluster Analysis:- Types of Data in Cluster Analysis, Model-Based Clustering Methods, Hierarchical and Partitioning methods. Outlier Analysis. Applications and trends in Data Mining: Mining Text and Web data.

Text Books/ References

1. Alex Berson,Stephen J. Smith, "Data Warehousing, Data Mining, & OLAP", Tata Mcgraw- Hill, 2004.
2. Jiawei Han. Data Mining: Concepts and Techniques. Morgan Kaufmann Publishers
3. Anahory and Murray .,Data warehousing in the real world ,Pearson Education/Addison Wesley.
4. Berry Micheal and Gordon Linoff,. Mastering Data Mining. John Wiley & Sons Inc.
5. Margaret H. Dunham Data Mining: Introductory and Advanced Topics. Prentice Hall

List of Lab Experiments

Basics of R
Pentaho installation
Data Cubes and Pivot tables in Pentaho
Integration of Data in Pentaho
Data Preprocessing and cleaning
Data Reduction
Association rule mining
Classification and Prediction
Cluster Anlayis
Outlier analysis
Mining web

ICS 322 MACHINE LEARNING [3-0-0-3]

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:

- 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;

Laboratory

Programming laboratory will be set in consonance with the material covered in lectures. This will include assignments in a programming language like C /C++ /MATLAB

Text Books/References

1. S. R. K. Iyengar, R. K. Jain, M. K. Jain Numerical Methods for Scientific and

Engineering Computation, 6th 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

IOE 321 SOFTWARE DESIGN PATTERNS [3-0-0-3]

Course Objectives

The aim of this course is to teach fundamental patterns in software. This includes some of the most popular architectural patterns, more than two dozen design patterns from creational, structural and behavioural categories.

Course Outcomes:

- Implement design patterns in Python
- Implement some of the design patterns in Java
- Use multiple design patterns in software development
- Apply the knowledge in their final semester project work

Syllabus

Design Pattern, Architectural Design Patterns, Describing Design Patterns, The Catalog of Design patterns, How Design patterns solve Design problems, How to select a Design Pattern, How to use a Design Pattern.

Architectural Patterns -- Layered architecture, Pipers and Filters, Blackboard, Broker, MVC, MVVM, Micro-Kernel, Master-Slave, PAC, others.

Creational Patterns : Singleton, Abstract Factory, Builder, Factory Method, Prototype, Implementation in various languages like Python, Java.

Structural Pattern Part – I: Adaptor, Bridge, and Composite.

Structural Pattern Part – II: Decorator, Arcade, Flyweight, Proxy.

Behaviour Patterns Part – I: Chain of Responsiblity, Command, Interpreter, and Iterator.

Behaviour Patterns Part – II: Mediator, Memento, Observer.

Behaviour Patterns Part – III State, Strategy, Template Method, Visitor.

Compound patterns, Case study: using design patterns to solve an industry level problem

Text Books/References

1. Eric Freeman, Elisabeth Freeman, Kathy Sierra, Bert Bates Head First Design Patterns, O'Reilly
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides Design Patterns: Elements of Reusable Objectoriented Software Addison-Wesley
3. Pattern's in JAVA Vol-I By Mark Grand, Wiley Dream Tech.
2. Pattern's in JAVA Vol – II BY Mark Grand, Wiley Dream Tech.
3. JAVA Enterprise Design Patterns Vol – III By Mark Grand, Wiley Dream TECH.
4. Head First Design Patterns By Eric Freeman – Oreilly – spd.
5. Peeling Design Patterns, Prof Meda Srinivasa Rao, Narsimha Karumanchi, and Career Monk Publication.
6. Design Patterns Explained By Alan Shallowy, Pearson Education.
7. Design patterns in Python, Rahul Verma, Chetan Giridhar

8. Pattern Oriented Software Architecture, af.Buschman & others, John Wiley & Sons.

SEMESTER VII

CSE411 Computer Graphics [3-0-3-4]

Course Objectives

- To understand the basic concepts of computer graphics and to have knowledge about the different hardware and software that supports computer graphics.
- To provide students with an understanding of the algorithms and theories that forms the basis for graphical objects.
- To understand the underlying algorithms and mathematical concepts that supports 2D and 3D viewing transformations and projections.
- To understand the different techniques used for rendering the graphical models.
- To analyse the characteristics of different color models.

Syllabus

Introduction to Computer Graphics: Overview of Computer Graphics-Raster refresh graphics displays- CRT-Flat Panel Displays- Hard copy output devices-Logical interactive Devices-Physical interactive devices-Data generation devices-Graphical user interfaces

Raster Scan Graphics: Line Drawing algorithms-Digital Differential Analyser- Bresenham's algorithm:-Integer Bresenham's algorithm, General Bresenham's algorithm, Faster line rasterisation algorithm- Circle generation-Ellipse generation-General function rasterisation- Scan conversions- Displaying line character and polygons-Polygon filling:- Scan converting polygons, Edge fill algorithm, Seed fill algorithms- Antialiasing-Halftoning

Two dimensional transformations: Representation of points- Transformations and matrices- transformation of points- Transformations of lines- Rotation-Reflection- Scaling- Combined transformations- Homogeneous coordinates

Windowing and clipping: Viewing transformations- Point clipping- Cohen Sutherland line clipping 2D Line clipping-Sutherland Hodge man Polygon clipping- Curve clipping-Text clipping

Three Dimensional Transformations and Projections: Three dimensional scaling, shearing, rotation, reflection, translations - Rotation about arbitrary axis Parallel to coordinate axis- Rotation about arbitrary axis in space- Affine and perspective geometry-Otho graphic projections-Taxonomic projections-Oblique projections.

Rendering and color models: Illumination model-Determining surface normal and reflection vector- Gouraud shading- Phong Shading-Texture mapping-Ray tracing- Color-Chromacity- Tristimulus theory of color-RGB color system -CMYK color system -HSV color system -HLS color system- Ostwald color System

Textbooks/References:

1. David F.Rogers, Procedural Elements for Computer Graphics, Second Edition, Tata McGraw-hill,2001,
2. David F.Rogers, Mathematical Elements for Computer Graphics, Second Edition, Tata McGraw- Hill,2001,
3. Francis S. Hill, Stephen M. Kelley, " Computer Graphics using OpenGL, Third Edition, Person Education India, 2015,
4. Donald D. Hearn, M. Pauline Baker, Warren Carithers, "Computer Graphics using OpenGL, Fourth Edition, Person Education India, 2013.
5. Amarendra N Sinha, Aurn D Udai , Computer Graphics , Tata McGraw-hill, 2011,
6. Donald Hearn ,Pauline Baker, Computer Graphics C version, 2/E Pearson Education ,2003.
7. Donald Hearn ,M Pauline Baker, Computer Graphics with OpenGL, 3/E, Pearson Education ,2004,
8. James D.Foley, Andries Van Dam,Steven K.Feiner, John F.Hughes, Computer Graphics Principles and Practice in C , 2/2, Pearson education, 2007.
9. Newmann W and Sproull R.F., Principles of Interactive Computer Graphics, 2/e, McGraw-Hill,1997.
10. C.S.Verma, Computer Graphics, Ane Books, 2011,
11. Edward Angel, Interactive Computer Graphics A Top-Down approach Using OpenGL, 5/e,

CSE412 Big Data Analytics [3-0-3-4]

Pre-requisite: Data warehousing and Data Mining

Course Objectives

- To know the fundamental concepts of big data and analytics.

- To explore tools and practices for working with big data.
- To learn about stream computing.
- To know about the research that requires the integration of large amounts of data.

Course Outcomes:

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

- Work with big data processing tools and its analysis techniques
- Design efficient algorithms for mining the data from large data set
- Design an efficient recommendation system
- Design the tools for visualization
- Learn NoSQL databases and management.

Syllabus

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Big Data Use Cases- Characteristics of Big Data Applications- Big Data Modelling- Hadoop Eco system.

An Overview of Clustering - K-means clustering - Use Cases - Determining the Number of Clusters - Classification- Decision Trees - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Bayes Theorem - Naive Bayes Classifier.

Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association & similarity - Recommendation System: Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation- Hybrid Recommendation Approaches

Introduction to Streams Concepts – Stream Data Model and Architecture - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream –Real time Analytics Platform(RTAP) applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.

NoSQL Databases - Schema less Models- Increasing Flexibility for Data Manipulation- Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases– Big data for twitter - Big data for E-Commerce blogs

Text Books/ References

1. Jure Leskovec, Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.
2. Tom White , Hadoop: The Definitive Guide, 4th edition O'Reily Publications, 2015
3. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
4. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
6. Dietmar Jannach, Markus Zanker, Alexander Felfernig and Gerhard Friedrich "Recommender Systems: An Introduction", Cambridge University Press, 2010.
7. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.
8. Jimmy Lin, Chris Dyer and Graeme Hirst, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.

ICS412 Cryptography and Network Security [3-0-3-4]

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.

IOE411 Blockchain Technology [3-0-0-3]

Prerequisites:

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

- Computer Networks
- Cryptography
- Linux commands

Course Objectives:

The Course Objectives are

- to introduce the concept and the basics of blockchain technologies,
- to provide knowledge on various applications of blockchain technologies
- to enable awareness on the different generations of blockchains.

Course Outcomes:

The Course Outcomes: are

- the students will have knowledge on various applications of blockchains.
- the students will have practical knowledge on implementing blockchain ledgers.
- the students will be capable to identify problems on which blockchains could be applied.

Syllabus

Introduction – blockchain history, basics, architectures, Types of blockchain, Base technologies – dockers, docker compose, and data structures, hashes, micro-services.

Bitcoins – Fundamentals, aspects of bitcoins, properties of bitcoins, bitcoin transactions, bitcoin P2P networks, block generation at bitcoins, consensus algorithms.

Blockchain hyperledger – Fabric architecture, implementation, networking, fabric transactions, demonstration, smart contracts.

Applications – blockchain applications, e-governance, smart cities, smart industries, anomaly detections, use cases, trends on blockchains, serverless blocks, scalability issues, blockchain on clouds.

Text Book/References:

1) Kevin Werbach, The Blockchain and the new architecture of Trust, MIT Press, 2018.

2) Joseph J. Bambara and Paul R. Allen, Blockchain – A practical guide to developing business, law, and technology solutions, McGraw Hill, 2018.

3) Joseph J. Bambara and Paul R. Allen, Blockchain, IoT, and AI: Using the power of

three to develop business, technical, and legal solutions, Barnes & Noble publishers, 2018.

4) Melanie Swan, Blockchain – Blueprint for a new economy, OReilly publishers, 2018.

5) Jai Singh Arun, Jerry Cuomo, Nitin Gaur, Blockchain for Business, Pearson publishers, 2019.

6) Journal Articles (specified in the course).

SEMESTER VIII

ICS422 Applied Predictive Analytics [3-0-0-3]

Course Objectives

- To extend student's knowledge in the area of Data Science with emphasis on Predictions utilizing associated statistical methods and software tools.
- Students shall better understand the use in its commercial application to a domain such as Telecommunication/ Insurance and should be able to independently work on a dataset using RStudio.

Course Outcomes

- Ability to apply specific statistical and regression analysis methods applicable to predictive analytics to identify new trends and patterns, uncover relationships, create forecasts, predict likelihoods, and test predictive hypotheses.
- Ability to develop and use various quantitative and classification predictive models based on various regression and decision tree methods.
- Develop familiarity with popular tools and software used in industry for predictive analytics, especially R, R Studio.
- Learn how to apply the models to interpret and report on results for a management audience for a domain such as Telecommunications / Insurance.

Syllabus

Introduction to supervised, unsupervised and semi-supervised modelling / learning

Regression model building framework: Problem definition, Data pre-processing; Model building; Diagnostics and validation

Simple Linear Regression: Coefficient of determination, Significance tests, Residual analysis, Confidence and Prediction intervals

Multiple Linear Regression: Coefficient of multiple coefficient of determination, Interpretation of regression coefficients, Categorical variables, Heteroscedasticity, Multi-collinearity, outliers, Auto regression and transformation of variables, Regression model building.

Logistic and Multinomial Regression: Logistic function, Estimation of probability using logistic regression, Deviance, Wald Test, Hosmer Lemshow Test, Classification table, Gini co-efficient; Classification and Regression Tree (CART), Decision Tree modelling.

Textbooks/References

1. James, Witten, Hastie and Tibshirani "An Introduction to Statistical Learning: with Applications in R" by, Springer, 1st. Edition, 2013.
2. Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014.
3. Eric Siegel, Thomas H. Davenport, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2013.
4. James R Evans, "Business Analytics – Methods, Models and Decisions", Pearson 2013.
5. R. N. Prasad, Seema Acharya, "Fundamentals of Business Analytics", Wiley, 2015.

ICS423 Internet of things [3-0-3-4]

Prerequisites:

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 attenuations.

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.

IOE421 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

BOUQUET CORE COURSES

1. CSE XXX Advanced Computer Networks

Course Objectives

The objective of the course is to provide the students with the advanced concepts of computer networks. The students will be introduced to the basics of networking; will be introduced to WSNs; and, will get a comparative study of wired and wireless networks. In addition, the course includes the practical sessions covering wired and wireless networking concepts via. simulations (for instance, Network Simulator-3).

Course Outcomes:

- understood the concepts of wired/wireless networks (WSNs),
- learned the importance of the energy concerns of WSNs,
- compared the protocols of wired/wireless networks;
- simulated the topologies of wired/wireless networks; and,
- studied the application of networks in emerging ICT domains.

Syllabus

Basics of computer networks --Types of networks, Topologies, Conversions, Data transmission basics, Bandwidth utilization techniques, Spread spectrum techniques, Layers and standards.

Wired/Wireless Phy/DLL -- Introduction to WSN, WSN-Single node architecture, Sensors and actuators, Design principles of WSN, Communication protocols – phy layer, MAC protocols (Wired and wireless).

Wired/Wireless DLL/NL -- Naming and addressing, Topology control, routing protocols for wired / wireless networks, Topology design using NS3 Toolkit.

Advanced Topics -- Data centric networking, content based networking, Data center networking, Networking and virtualization, Software Defined Networking, Cloud networking.

Lab Components:

NS3 and Eclipse IDE installation; Logging exercises of NS3; Topology study using NS3; Tracing using NS3; public/private key authentication; passwordless connection establishment; setting up firewall.

Text Books/References

1. Andrew S. Tanenbaum, Computer Networks, Pearson Education, Fifth Edition, 2003.
2. Fred Halsal, Data communications Computer Networks and Open Systems, Pearson Education, Fourth Edition, 1992.
3. Holger Karl and Andreas Willing, Protocols and Architectures for Wireless Sensor Networks, John Wiley and Sons, First Edition, 2005.
4. Paul Gorransson and Chuck Black, Software Defined Networks - A Comprehensive Approach, Morgan Kauffman publishers, First Edition, 2014.

2. CSE XXX Data Communications

3. CSE XXX Advanced Database System

4. CSE XXX Embedded System

5. CSE XXX Mobile Networks

CS ELECTIVE COURSES

ICS XXX Parallel Algorithms

Course Objectives

The objective of this course is to learn principles and design techniques of parallel algorithms, parallel and distributed algorithms development techniques for shared memory and message passing models; to study the main classes of parallel algorithms; to study the implementation of parallel algorithms using PyPVM, PyMPI and OpenMP.. This course is aimed at undergraduate

students who are interested in the algorithmic aspect of parallel computation.

Course Outcomes:

- Understand fundamental concepts of parallel algorithmics
- Design parallel algorithms for sorting, searching, matrix algorithms etc
- Write parallel programs in PyPVM and PyMPI
- Understand Fourier transforms and its parallel versions
- Understand connection networks like butterfly, omega and other networks

Syllabus

History of computers, Examples of parallel computers, Application areas of supercomputers, Von Neumann architecture, Flynn's Taxonomy (SISD,SIMD,MISD,MIMD), SPMD, Vector/Array and Grid processors, Cluster computers, Master-slave vs Client-server models, vertical vs horizontal scaling of CPU, Map-Reduce models.

Performance measures, Speed-up, Efficiency, Gantt chart, Amdahl's law, Gustafson-Barsis law, granularity and scalability.

Shared memory architectures

PRAM models, CRCW, CREW, ERCW, EREW, NUMA etc
Memory interconnections -- BUS, CROSSBAR, OMEGA NETWORKS, TREE, PERFECT SHUFFLE Threads vs processes, issues in thread-based parallel algorithms
Some Shared memory algorithms: sieve of Erasthosthenes, LU Decomposition, Odd-Even Transposition sort, Batcher's Bitonic Sort

Distributed Memory Machines

Examples of computers in this category, and software packages PVM, MPI, OpenMP
Basics of message passing, process creation, synchronisation, some application areas
Hypercube architectures

CommunicationMethods-peer-to-peer, collective broadcast, one-to-all, all-to-all, gather and scatter, other

Criteria for model selection

Communication cost and Latency, Load Balancing, Processor scheduling, Scalability, Fault-Tolerance

Load balancing

Dynamic load balancing - synchronized vs asynchronized, centralized vs decentralized, termination detection algorithms, graph representations

Divide and Conquer (D&C) algorithms

D&C vs decrease and conquer, parallel implementation of D&C algorithms, partitioning strategies

Matrix algorithms

Transposition, LU decomposition, determinant, solving linear equations, matrix-vector multiplication, matrix multiplication, Strassen's algorithm, matrix inverse

Sorting algorithms

Bubble sort, insertion sort, merge sort, quick sort, odd-even transposition sort, Batcher's bitonic sort, bucket-sort, sorting on hypercube, sorting networks Searching algorithms

Linear search, binary search, parallel searching strategies, speedup anomalies in Parallel searching algorithmsGraph algorithms

BFS, DFS, spanning trees, Shortest path, Dijkstra's and Prims algorithms

Fast Fourier TransformSerial algorithm, Binary-Exchange algorithm, Transpose algorithm

Emerging areas of parallel algorithms.

Text Books/Reference

1.Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2nd Edition By Barry Wilkinson, Michael Allen Pearson; 2 edition (4 March 2004)
2.An Introduction to Parallel Computing: Design and Analysis of Algorithms, 2e Paperback 2004 Anand Grama, Anshul Gupta, George Karypis, Vipin Kumar Pearson Education India; 2 edition (2004)
3.Parallel Computing: Theory and Practice Paperback – 1 Jul 2017 Michael Quinn J, McGraw Hill Education; 2 edition (1 July 2017)
4.Parallel Sorting Algorithms Paperback – 1 Jan 1985 Selim G. Akl, Academic Press (1 January 1985)
5.Parallel Computation: Models and Methods, Selim G. Akl, Pearson (6 November 1996)

CSE XXX Advanced Network Security

Prerequisite: ICS224 Computer Networks

Course Objectives

- Comprehend the necessity of network security along with the basic concept of Network security.
- Analyse passwords and understand the security issues like Brute force attack, Dictionary attack and rainbow table attack associated with passwords.
- Investigate various network vulnerabilities like virus, worm, malware, rootkit and devise strategies to mitigate them.
- Analyse privacy threatening behaviour over the internet and formulate defensive techniques to preserve privacy.
- Discuss and learn data privacy laws in India and in Europe. Examine Information Technology Act in India along with its amendments.

Course Outcomes:

- Understand the need for network security and have through grasp of the fundamentals of network security.
- Recognise network vulnerabilities and develop Network defensive strategies by utilizing Intrusion Detection Systems, Honeypot etc.
- Comprehend various legal perspective regarding data security and privacy in India and Europe. Develop a clear perception of Information Technology Act in India.
- Identify and defend against various privacy threatening tools and techniques over the internet.

Syllabus

Introduction to Network Security, Need for Network Security, Network Security Fundamentals, Principles of Security, DNS Vulnerabilities, Secure Network Communication.

Access Control, Password Attacks, Password Policies, Rainbow Table Attack, Social Engineering, Malware, Insider Attack and Defence, Computer Virus Types and Defence, Computer Worms, Rootkits, Botnet, Denial of Service Attack.

Need For Physical Security, User Authentication Technologies, Environmental Attacks and Accidents, Special-Purpose Machines and Security, Firewall, Intrusion Detection System, Honeypot, Tunnelling, Virtual Private Network.

Privacy Preserving Communication, Anonymity, Onion Routing, Device Fingerprinting, Data Protection Laws in India, Data Protection Act in European Union, Information Technology Act of 2000 and its amendments.

Text Books/References

1. Michael Goodrich, Roberto Tamassia, Introduction to Computer Security: Pearson New International Edition, Published 15 Aug 2013, ISBN-10: 1292025409, ISBN-13: 9781292025407.
2. Kun Peng, Anonymous Communication Networks: Protecting Privacy on the Web, Auerbach Publications, 1st edition, Published: 7 April 2014, ISBN-10: 143988157X, ISBN-13: 978-1439881576.
3. Christopher Hadnagy, Social Engineering: The Science of Human Hacking, Publisher: Wiley, 2nd Edition Publication date: July 31, 2018, ISBN-10: 111943338X, ISBN-13: 978-1119433385.
4. Chris Sanders, Jason Smith, Applied Network Security Monitoring: Collection, Detection, and Analysis, Publisher: Syngress, 1st edition Publication Date: December 19, 2013, ISBN-10: 0124172083, ISBN-13: 978-0124172081.
5. Sagar Rahalkar, Quick Start Guide to Penetration Testing: With NMAP, OpenVAS and Metasploit, Publisher: Apress; 1st edition Publication Date: 21 Jan. 2019, ISBN-10: 1484242696, ISBN-13: 978-1484242698.

Research Papers

1. A. C. Jose, R. Malekian, and N. Ye, "Improving home automation security; Integrating device fingerprinting into smart home," IEEE Access, vol. 4, pp. 5776–5787, 2016.
2. J. R. Mayer, ''Any person... a pamphleteer: Internet anonymity in the age ofWeb2.0,''M.S.thesis,Dept.SchoolPublicInt. Affairs,PrincetonUniv., Princeton, NJ, USA, 2009.
3. P. Eckersley, ''How Unique Is Your Browser?'' in Proc. 10th Privacy Enhancing Technol. Symp. (PETS), Berlin, Germany, Jul. 2010, pp. 1–35.
4. T.-F. Yen, Y. Xie, F. Yu, R. P. Yu, and M. Abadi, ''Host fingerprinting and tracking on the Web: Privacy and security implications,'' in Proc. 19th Annu. Netw. Distrib. Syst. Secur. Symp. (NDSS), San Diego, CA, USA, Feb. 2012.
5. N. Nikiforakis, A. Kapravelos, W. Joosen, C. Kruegel, F. Piessens, and G. Vigna,

''Cookieless monster: Exploring the ecosystem of Web-based device fingerprinting,'' in Proc. IEEE Symp. Secur. Privacy, May 2013, pp. 541–555.
6. K. Mowery, D. Bogenreif, S. Yilek, and H. Shacham, ''Fingerprinting information in JavaScript implementations,'' in Proc. W2SP, May 2011, pp. 1–11.
7. T. Kohno, A. Broido, and K. Claffy, ''Remote physical device fingerprinting,'' IEEE Trans. Dependable Secure Comput., vol. 2, no. 2, pp. 93–108, Apr./Jun. 2005.
8. S. Zander and S. J. Murdoch, ''An improved clock-skew measurement technique for revealing hidden services,''inProc.17th Conf. Secur.Symp., Berkeley, CA, USA, 2008, pp. 211–225.

ICS XXX Human Computer Interaction

Pre-requisites: OOAD

Objectives:

- Learn the foundations of Human Computer Interaction
- Be familiar with the design technologies for individuals and persons with disabilities
- Be aware of mobile HCI
- Learn the guidelines for user interface.

Syllabus

Foundation of HCI:
HCI foundation and history; The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Design and Software Process: Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Model-based Design and evaluation: Basic idea, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS), Fitts' law and Hick-Hyman's law, Model-based design case studies;

Guidelines in HCI: Shneiderman's eight golden rules, Norman's seven principles, Norman's model of interaction, Nielsen's ten heuristics with example of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough;
Task modelling and analysis: Hierarchical task analysis (HTA), Engineering task models and Concur Task Tree (CTT)

Dialog Design: Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and(classical) Petri Netsin dialog design;

Cognitive models and architecture: Socio-Organizational issues and stake holder requirements –Communication and collaboration models ; Introduction to Cognitive Architecture, Cognitive Architecture types, relevance of Cognitive Architecture in IS design, Model Human Processor (MHP);
OOM- Object Oriented Modeling of User Interface Design; Design Case Studies

Text books/References

1. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition,Pearson Education, 2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.
3. B. Shneiderman; Designing the User Interface, Addison Wesley 2000.
4. Brian Fling, "Mobile Design and Development", First Edition , O"Reilly Media Inc., 2009.
5. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O"Reilly, 2009.

Other CS Stream Electives

Speech and Language Technology

1. Digital Signal Analysis & Applications
2. Speech & Natural Language Processing- I
3. Speech & Natural Language Processing –II
4. Natural Language Dialog Systems

Robotics Stream

1. Introduction to Robotics
2. Embedded Robotics
3. Mobile Robotics
4. Multi Agent Systems

Information and Network Systems

1. Principles of Information Security
2. Information Theory & Coding

3. Advances in Information Security
4. Multi Core Architecture

Image and Vision Technology

1. Digital Analysis & Applications
2. Computational Geometry
3. Computer Vision

Algorithm and Computing

1. Distributed Computing
2. Parallel Computing
3. Quantum Computing
4. Neural Computing

ELECTRONICS ELECTIVE COURSES

1. Data Communications

MATHEMATICS ELECTIVE COURSES

1.IMA XXX Elementary Number Theory and Cryptography

Course Objectives

- To learn the basics of Elementary number theory and Cryptography.
- Use their programming skills to attack some classical problems in Number theory like Pells equation by obtaining continued fraction expansion of quadratic irrationals.

Syllabus

Divisibility, Greatest Common Divisor, Euclid's algorithm, Linear diophantine equations, prime numbers, fundamental theorem of arithmetic, Linear Congruences, Chinese remainder theorem, Basics of group theory, examples of groups such as Z_n and (Z_n)*, Group table, order of group, lagrange's theorem, Wilson's theorem, Fermat's little theorem, Euler's theorem, Arithmetic functions, Euler Totient function, sum of divisors function, Pillai's arithmetic function, Perfect numbers, primitive roots, Quadratic residues, Legendre symbol, law of quadratic reciprocity, Jacobi symbol, Jacobi Reciprocity Theorem, Continued Fractions, Pells Equation, solution of pells equation using continued fractions. Fermat's sum of 2 squares theorem.

A Final project involving programming and number theory. Challenges by Fermat related to Pells equation was assigned as projects to write a programming code and to obtain the fundamental solution.

Text Books/Reference

1. David M. Burton, Elementary Number Theory, 7th Edition, Mcgraw Hill, 2012.
2. Neal Koblitz, A Course in Number Theory and Cryptography, Springer, Second Edition, 1994.
3. Ivan Niven, H. S. Zuckerman and H. L. Montgomery, An Introduction to the Theory of Numbers, Wiley, Fifth Edition, 1991.
4. Alexander Stanoyevitch, Introduction to Cryptography with Mathematical Foundations and Computer Implementations, Chapman and Hall/CRC,First Edition, 2010.

2.IMA XXX Optimization Techniques

Objectives

- To explain the basic mathematical concepts of optimization.
- To develop the modelling skills necessary to describe and formulate optimization problems.
- To conduct and interpret the post optimal and sensitivity analysis and explain the primal-dual relationship.
- To provide the skills necessary to solve and interpret optimization problems in engineering.

Outcomes

- Apply knowledge of optimization to formulate and solve engineering problems.
- Understand the different methods of optimization and be able to suggest a technique for a specific problem.
- Understand how optimization can be used to solve industrial problems.

Classification and general theory of optimization; Linear programming (LP): formulation and geometric ideas, simplex and revised simplex methods, duality and sensitivity, interior-point methods for LP problems, transportation, assignment, and integer programming problems;

Nonlinear optimization, method of Lagrange multipliers, Karush-Kuhn-Tucker theory, numerical methods for nonlinear optimization, convex optimization, quadratic optimization; Dynamic programming;

Text Books/Reference

1. D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, Third Edition, Springer India, 2008.
2. N. S. Kambo, Mathematical Programming Techniques, East-West Press, 1997.
3. E. K. P. Chong and S. H. Zak, An Introduction to Optimization, Second Edition, Wiley India, 2001.
4. M. S. Bazarra, H. D. Sherali and C. M. Shetty, Nonlinear Programming Theory and Algorithms, Third Edition, Wiley India, 2006.
5. K. G. Murty, Linear Programming, Wiley, 1983.

3. IMA XXX Estimation and Detection Theory

Course Objectives:

- To study estimation techniques
- To study detection techniques.
- To estimate parameters for a given application
    - To apply detection techniques for a given application

Course Outcomes:

- Apply detection techniques in complex problem
- Estimate parameters for a given application
- Analyze performance of communication systems using various detection/estimation schemes

Syllabus

Fundamentals of Estimation Theory:

Role of estimation in signal processing, unbiased estimation, minimum variance unbiased (MVU) estimators, finding MVU estimators, Cramer-Rao lower bound, linear modelling-examples.

Deterministic Parameter Estimation:

Least squares estimation, linear and nonlinear, best linear unbiased estimation (BLUE), examples, finding the BLUE, maximum likelihood estimation (MLE), numerical determination of the MLE

Random Parameter Estimation:

Bayesian philosophy, prior knowledge and estimation, choosing a prior PDF, Bayesian linear model general Bayesian estimator, risk functions, minimum mean square error estimator, maximum a posteriori estimator, performance characterization.

Fundamentals of Detection Theory:

Bayesian criterion, binary hypothesis testing, M-ary hypothesis testing, minimax criterion, Neyman-Pearson criterion, receiver operating characteristic, composite hypothesis testing, θ-random variable and θ- nonrandom and unknown, sequential detection.

Applications of Detection and Estimation: Applications in communications, system identification, pattern recognition, speech processing, and image processing.

Reference Books:

1. S.M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice hall, 1993.
2. S.M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice hall, 1998.
3. M.Barkat, Signal Detection and Estimation, Artech House, 2nd edition, 2005.
4. H.V.Poor, An Introduction to Signal Detection and Estimation, Springer, 2nd edition, 1998.
5. H.L.Van Trees, Detection, Estimation and Modulation Theory, Part-I, John Wiley, 1968.

4.IMA XXX Algorithmic Graph Theory

Course Objective

- To introduce and apply algorithmic paradigms for graph theoretic problems.
- Computability and complexity aspects restricted to graph-theoretic problems shall be explored.
- Spe-cial graphs and their structural properties shall also be explored. Handling graphs using Neo4j

Course Outcome

- Tools for design and analysis of algorithms for graph-theoretic problems shall be the key outcome of this course.
- Art of proof writing, establishing proof of correctness of algorithms and familiarizing Neo4j shall be the additional outcome.

Syllabus

Introduction to search and spanning tree problems - Variants such as second best spanning tree, K^{th}-best spanning tree, Steiner tree. Shortest path problems and variants - Dijkstra's algorithm, data structures - Binomial and Fibonacci heap for running shortest path problems, analysis. Bidirectional Dijkstra and A-star algorithms. Introduction to Neo4j - Graph creation and querying - cypher query language - CREATE, MATCH, WHERE and RETURN clauses

All pair shortest path algorithms. Maximum Flow problems - Ford-Fulkerson al-gorithm, Maximum bipartite matching algorithms, push-relabel methods and analysis. Imple-mentation of these algorithms using python and Neo4j.

Basic Graph-theoretic concepts, Structural properties of special graph classes (chordal graphs, bipartite graphs, chordal bipartite graphs, planar graphs, etc.) and algorithmic aspects along with sophisticated data structures. The complexity of classical problems such as minimum vertex cover, minimum independent set, maximum clique,

Theory of NP-completeness - Classical NP-hard reductions - Reductions in special graphs - Complexity of Hamiltonian cycle/path in special graphs. Dichotomy results - Micro-level analysis of reductions - Discovery of polynomial-time solvable input instances.

References /Text Books

1. Thomas H. Cormen. Charles E. Leiserson. Ronald L. Rivest. Cli ord Stein. Introduction to Algorithms. Third Edition. The MIT Press, 2009.
2. Ian Robinson, Jim Webber and Emil Eifrem. Graph Databases. Second Edition. O'Reilly Media, Inc., 2015. (online free e-book is available)
3. Martin Charles Golumbic, Algorithmic Graph Theory and Perfect graphs, Annals of Discrete Mathematics, 57, 1980.
4. Andreas Brandstadt, Van Bang Le, Jeremy P. Spinrad, Graph Classes - A Survey, Mono-graph, SIAM, 1999.

HUMANITIES ELECTIVE COURSES

IHS XXX Introduction to Sociology

Course Objectives

- To understand the relationship between Science, Technology, Society and Culture.
- To familiarize with the social processes and dynamics of scientific knowledge and developments in Social Sciences
- To introduce Sociology as a science of society vis-à-vis Science and Technology.
- To know the fundamental social processes and institutions such as socialization, marriage, family, caste, gender etc.
- To discuss some of the important issues and problems in India today

Course Outcomes:

- The relationship between Science, Technology, Society and Culture.
- Social processes and dynamics of scientific knowledge and developments in Social Sciences
- Sociology as a science of society vis-à-vis Science and Technology
- The fundamental social processes and institutions of socialization, marriage, family, caste and gender.
- Some of the important issues and problems in India today, such as Communalism, Diversity and Pluralism, Fundamentalism, Secularism, Globalization, Liberalization, Information Communication Revolution etc.

Syllabus

Sociology & Social Sciences, Science, Social Science and Society, Scientific Study of Society, Sociology – Science of Society; ,Approaches & Methods: Macro & Micro – Object & Subject, Objectivist & Interpretativist

Society, Social Structure & Culture ,Nature & Culture: Science and Society Interface ,Society and social structure,Culture ,Socialization, Social Institutions – Marriage, Family, Caste, Class & Gender

India today – major issues and challenges,Diversity & Pluralism,Secularism & Communalism,Globalization & Consumer Culture,Information Communication Revolution – New media

Text Books/References

1. Haralambos, Michael with Robin Heald. Sociology – Themes and Perspectives. NewDelhi : Oxford University Press, 1980.
2. Mohanty, Manoranjan, Class, Caste, Gender. New Delhi: Sage Publications, 2004.
3. Perry and Perry, Contemporary Society: An Introduction to Social Science. London: Allyn & Bacon, 2008.
4. Bryman Alan, Social Research Methods, Oxford University Press, Oxford, 2005.
5. Srinivas M.N, Caste in India and Other Essays. Delhi: Asia Publishing House, 1962.

6. Patel, Tulasi. The Family in India: Structure and Practice. New Delhi: Sage, 2005.
7. Knott-Cetina, Karin and Michael Mulkay, Science Observed: Perspectives on the
8. Social Study of Science. London: Sage Publications, 1983.Merton, Robert K, The Sociology of Science. Chicago: Univ. of Chicago Press, 1973.
9. Bijker, W. E. , Social construction of technology'', International Encyclopedia of the Social and Behavioural Sciences. N. Smelser and P. Bailes, eds. Amsterdam, 2001.
10. Sarah Franklin, "Science as Culture, Cultures of Science," Annual Reviews of Anthropology 1995.
11. Sharma, K.L, Indian Social Structure and Change. Jaipur: Rawat Publications, 2007.
12. Bruno Latour and Steve Woolgar, Laboratory Life: The Construction of Scientific Facts Princeton NJ: Princeton University Press, 1986.

2.IHS XXX Taxation and Human Development /Economics

Course Objectives

The course seeks to sensitise the students to concepts of income, human development, government's role in development, governance functions and taxation. It aims at raising the capacity of non- economics students to appreciate the need to understand some of these concepts for good citizenship as well for becoming able technologists.

Syllabus

Taxation and Central Transfers**,** Introduction to National Income**,** Gross Domestic Product (GDP)**,** Gross Domestic Product and Gross National Income(GNI)**,**Three Approaches to GDP**,** System of National Accounts and Production Boundary, Household's non-market Production,Women, Work, and the Economy:,Macroeconomic Gains from Gender Equity,Measuring Government Output**,** Satellite Account**,**Tourism Satellite Account for India**,** GDP to Welfare Measures,Human Development Index ,Purchasing Power Parities, National Income and Quarterly estimates of Gross Domestic Product (mospi.nic.in)**.**

Text Books/References

1. Ann Chadeau ( ) What Is Households' Non-Market Production Worth? OECD Economic Studies No. 18, Spring 1992.
2. Katrin Elborgh-Woytek et al., (2013) Women, Work, and the Economy: Macroeconomic Gains from Gender Equity, IMF SDN/13/10.
3. Lequiller, F. and D. Blades (2014), Understanding National Accounts: Second Edition, OECD Publishing. (http://dx.doi.org/10.1787/9789264214637-en)
4. UNDP, Human Development Report 1990 and 2016.

3. IHS XXX Introduction to Psychology

Psychological Science- Assumptions, schools, methods of doing psychology research, The relationship between brain, body and mental functioning, Sensation, perception and making sense of the world, Consciousness, Life span development and motor and language development, Nature and nurture controversy, The learning process and some important explanations of how we learn, Meaning of motivation and explanations, Theories of emotions and expression and regulation of emotions, Basic cognitive processes, Language development, why we remember and why we forget- some explanations, Different kinds of intelligence, explanations of creativity, Differences among individuals and explanations for personality differences, Application of psychology to everyday life- enhancing health and well-being, performance, social relations, and sensitivity to environmental, social and cultural contexts ;De-stressing the mind.

4. IHS XXX Environment, Development and Society

Students will be exposed to contemporary themes and debates on connection between environment, development, and society; industrialization and risk society; challenge of sustainable development; perception of the environment, dependence for livelihood, identity, and power on natural resources; social ecology; what is the role of religion in determining our world view and relation with the environment?; recognition of indigenous knowledge; rise of environmental movements, development projects and recent conflict over natural resources; understanding major environmental disasters and industrial accidents; global climate change negotiations; gender and environment. Sustainable development.

5. IHS XXX Science, Technology and Society

The course will begin with social theories on the production of technology and scientific knowledge systems, stratification within the community of technologists and scientists, discrimination (race, class, gender, caste) and the role of power in shaping the production of technology and scientific knowledge. Scientific controversies, both historical and emerging, and the organization of innovation and its geographies will be discussed. Case studies exploring ethical questions arising from new technologies such as information technology, nanotechnologies, biotechnologies, etc. will be used. Discussions on public understanding of science and role of the public and of experts in influencing policies related to science and technology will conclude the course.

5. IHS XXX Introduction to Logic

In this course, students are introduced to fundamentals of informal logic and verbal analysis, material and formal fallacies of reasoning often found ordinary discourse, deductive and Inductive reasoning, validity and soundness, formal rules and principles of the deductive system of Aristotelian logic, traditional square of opposition; propositional calculus; first order predicate calculus; the modern square of opposition and the problem of existential import; identity and definite descriptions; methods for formulating natural language arguments in symbolic forms and techniques for checking their validity; various meta-logical theorems and their proofs.

7.IHS XXX Introduction to Philosophy

What makes philosophical thinking radically critical? Investigation of the nature of knowledge about the world and justification of knowledge claims. Metaphysical understanding of the Absolute and Mind-Body relation. The nature of ethical and aesthetic beliefs and attitudes as part of understanding the nature of values. The discussion of the above issues will be influenced by three philosophical orientational perspectives: Anglo-American Analytic, Continental Phenomenological and Classical Indian School of Philosophy.

8.IHS XXX. Philosophy of Mind

An appreciation of how the fundamental mental concepts are essentially amenable to philosophical sense over and above their usual psychological understanding and analysis. To explain why our mental conceptual scheme does not easily admit of their reduction to physical conceptual scheme. To reflect on whether mentally endowed human person differ, ontologically, from the rest of nature, yoga shastra.

9. IHS XXX Communication Skills (Advanced Level)

Introduction to major grammatical models. Phonological and syntactical structure of present- day English. Language of science and technology. Aspects of style. Some common errors. Technical presentations design and delivery. Audio Visuals in communication. Collecting materials for research. Organization of research paper/dissertation

10. IHS XXX Introduction to Economics

What is Economics? Scarcity, choice and economic systems; Supply and demand; elasticity of demand; Comparative advantage and international trade; Consumer choice; Consumer theory with indifference curves; Production and cost; How firms make decisions: profit maximization; Perfect competition; Monopoly and imperfect competition; Economic efficiency and the role of government; Labor markets and wages; Introduction to macroeconomics; Production, income and employment; The monetary system, prices and inflation; Economic growth & rising living standards; Economic Fluctuations; The banking system, the Fed & monetary policy; Aggregate demand and aggregate supply

11 IHS XXX. Planning and Economic Development (Advanced Level)

Economic growth. Economic development. Historic growth and contemporary development. Lessons and controversies. Characteristics of developing countries. Obstacles to development. Structural changes in the process of economic development. Relationship between agriculture and industry. Strategies of economic development. Balanced/ Unbalanced growth. International trade and economic development. Population. Planning for economic development. Use of input-output model and linear programming techniques in planning.

Indian plan experience. Strategy of Indian planning. Indian plan models.

12 IHS XXX. Human Values

Introduction: Relevance of Values, Objectives of Value Education, Sources of Values

Personal Values: Dignity of labour, Regularity and Punctuality, Concern for environment-Cleanliness, Team spirit -- Sportsman spirit, Be Pro-active & sharing-Be smart &sharp,Courage,Health, Creativity, Self-motivation, Victory over bad habits.Social Values: Accountability, Hospitality, Justice, Magnanimity & Charity, Service mindedness, Tolerance, Faithfulness, Determination/ Be strong-willed, Appreciation, Organ /blood donation
Moral&BehaviouralValues:FaithinGod, Friendship,Love,Integrity&truthfulness,Sensitivity,Selflessness.Etiquette: Courtesy, Table manners, Professional etiquette -Telephone etiquette, Email etiquette,
Meeting Etiquette, etc. Dress Code, A true lady/gentleman, Let's fly high.