B.Sc. (COMPUTER SCIENCE & ENGINEERING)

FIRST YEAR - FIRST SEMESTER

Subject Code	Subject	Theory/Tutorial/Lab./Credits
IMA 111	Mathematics - I	3 – 1 – 0 – 4
IPH 111	Physics - I	3 – 0 – 0 – 3
ICE 111	Mechanics of Solids	3 – 1 – 0 – 4
ICS 111	Problem Solving Using Computers	3 – 1 – 3 – 5
IHS 111	A Course on Psychology for Engineers	3 – 0 – 0 – 3
IHS 112	Communication Skills in English	3 – 0 – 0 – 3
IME 111	Engineering Graphics - I	0 – 0 – 3 – 1
		18 – 3 – 6 – 23

SECOND SEMESTER

Subject Code	Subject	Theory/Tutorial/Lab./Credits
IMA 121	Mathematics - II	3 – 1 – 0 – 4
IPH 121	Physics - II	3 – 0 – 3 – 4
ICH 121	Chemistry	3 – 0 – 0 – 3
ICS 121	Data Structures	3 – 1 – 0 – 4
ICS 122	Switching Circuits and Logic Design	3 – 0 – 0 – 3
ICS 123	Computer Organization and Architecture	3 – 0 – 0 – 3
ICS 124	Data Structures Laboratory	0 – 0 – 3 – 1
ICS 125	Switching Circuits and Logic Design Laboratory	0 – 0 – 3 – 1
		18 – 2 – 9 – 23

SECOND YEAR - THIRD SEMESTER

Subject Code	Subject	Theory/Tutorial/Lab./Credits
IMA 231	Mathematics - III	3 – 1 – 0 – 4
IEC 231	Analog Electronic Circuits	3 – 1 – 0 – 4
ICS 231	Database Management Systems	3 – 0 – 0 – 3
ICS 232	Software Design using Object Oriented Paradigm	3 – 0 – 0 – 3
ICS 233	Database Management Systems Laboratory	0 – 0 – 6 – 2
ICS 234	Software Design using Object Oriented Paradigm Laboratory	0 – 0 – 3 – 1
ICS ***	Program Elective - 1	2 – 1 – 0 – 3
ICS ***	Program Elective - 2	3 – 0 – 0 – 3
		17 – 3 – 9 – 23

FOURTH SEMESTER

Subject Code	Subject	Theory/Tutorial/Lab./Credits
IEE 241	Signals and Signal Processing	3 – 1 – 0 – 4
ICS 241	Embedded Systems	3 – 0 – 0 – 3
ICS 242	Operating Systems	2 – 1 – 0 – 3
ICS 243	Design and Analysis of Algorithms	2 – 1 – 0 – 3
ICS 244	Embedded Systems Laboratory	0 – 0 – 3 – 1
ICS ***	Program Elective - 3	3 – 0 – 0 – 3
ICS ***	Program Elective - 4	3 – 0 – 0 – 3
ICS ***	Program Elective - 5	0 – 0 – 6 – 2
		16 – 3 – 9 – 22

PROGRAM ELECTIVES

Subject Code	Subject
ICS 235	Introduction to Data Analytics with Python
ICS 236	Artificial Intelligence
ICS 237	Machine Learning
ICS 245	Big Data Analytics
ICS 246	Artificial Neural Network
ICS 247	Data Warehousing and Data Mining
ICS 248	Machine Learning Laboratory
ICS 249	Big Data Analytics Laboratory

PROGRAM ELECTIVE BASED STREAM SPECIALIZATIONS

1. ARTIFICIAL INTELLIGENCE & MACHINE LEARNING :

THIRD SEMESTER: ICS 235, ICS 236

FOURTH SEMESTER: ICS 237, ICS 246, ICS 248

2. BIG DATA ANALYTICS :

THIRD SEMESTER: ICS 235, ICS 237

FOURTH SEMESTER: ICS 245, ICS 247, ICS 249

DETAILED SYLLABUS
I SEMESTER
(Common to all branches)

MATHEMATICS - I

IMA 111 **3 - 1 - 0 - 4**

Successive differentiation, polar co-ordinates, angle between polar curves, derivative of arc length, curvature, radius of curvature and evolutes. (12 hours)

Rolle's Theorem, mean value theorems - Lagrange's and Cauchy's mean value theorems, Taylor's theorem, Maclaurin's series development, indeterminate forms and L'Hospital's Rule. (6 hours)

Functions with two or more variables, partial differentiation - basic concepts, Euler Theorem of homogeneous functions, total derivatives, composite functions, implicit functions, chain rule, error and approximation. Taylor's and Maclurin's series for two variables, Maxima and minima for functions of two or more variables, and Lagrange's method of undetermined multipliers. (14 hours)

Infinite series, series with positive terms - test of convergence, comparison test, D'Alembert's ratio test, Cauchy's root test, Raabe's test, integral test, alternating series - Leibnitz's rule, power series, radius of convergence and interval of convergence. (8 hours)

Reduction formulae, curve tracing, application of integration to find arc length, area of the plane regions, surface area of revolution, volume of revolution. (8 hours)

Text/Reference:

- Calculus and Analytical Geometry - IV Edn., George B. Thomas Jr. (1992), Addison Wesley Publications.
- Calculus & Analytical Geometry - George B. Thomas Jr & Ross L. Finney (1998), Addison Wesley Publications.
- Higher Engineering Mathematics, Grewal B. S., Grewal J. S. (2015), Kanna Publishers.
- Calculus, James Stewart, Cengage Publ. 8th Edn.

PHYSICS - I

IPH 111 **3 - 0 - 0 - 3**

Optics: Interference of Light Waves: Conditions for interference, Young's double-slit experiment, Intensity distribution of the double-slit interference pattern, Phasor addition of waves, Change of phase due to reflection, Interference in thin films, The Michelson Interferometer. Diffraction Patterns and Polarization: Introduction to diffraction patterns, Diffraction patterns from narrow slits, Resolution of single-slit and circular apertures, The diffraction grating, Diffraction of X-rays by crystals, Polarization of light waves. (10 hours)

Modern Physics: Introduction to Quantum Physics: Blackbody radiation and Planck's hypothesis, The photoelectric effect, The Compton effect, Photons and electromagnetic waves, The wave properties of particles, The quantum particle, The double-slit experiment revisited, The uncertainty principle. (6 hours)

Quantum Mechanics: An interpretation of quantum mechanics, A particle in a box, The particle under boundary conditions, The Schrodinger equation, A particle in a well of finite height, Tunneling through a potential energy barrier, Applications of tunneling, The simple harmonic Oscillator. (6 hours)

Atomic Physics: Atomic spectra of gases, Early models of the atom, Bohr's model of the hydrogen atom, The quantum model of the hydrogen atom, The wave functions for hydrogen, Physical interpretation of the quantum numbers, More on atomic spectra: visible and X-ray, Spontaneous and stimulated transitions, Lasers. (6 hours)

Solid state Physics: Molecules and Solids: Molecular bonds, Energy states and spectra of molecules, Bonding in solids, Free-electron theory of metals, Band theory of solids, Electrical conduction in metals, insulators, and semiconductors, Semi conductor Devices, Superconductivity. (8 hours)

Text/Reference:

- Serway & Jewett; Physics for Scientists and Engineers with Modern Physics; Volume 2; 6e, Thomson.
- Halliday, Resnick, Krane; Physics; Volume 2; 5e, John Wiley and Sons, Inc.

MECHANICS OF SOLIDS

ICE 111 **3 - 1 - 0 - 4**

Part-A: Mechanics of Rigid Bodies:

Introduction: basic principles and concepts. (1 hour)

Resultant of coplanar concurrent and non-concurrent force system: Resolution, composition, moment of force, Varignons theorem, couple, application problems. (6 hours)

Equilibrium of Coplanar concurrent and noncurrent force system: Conditions of Equilibrium, Space and Free body diagram, Lami's theorem- application problems. Support reaction, types of loading, friction- application problems. (6 hours)

Centroid and Moment of Inertia: Simple and composite areas, application problems. (8 hours)

Kinetics: Applications of D'Alembert's, Work-Energy and Impulse Momentum principles. (9 hours)

Part-B: Mechanics of Deformable Bodies:

Simple Stresses and Strains: Normal stress and strain, mechanical properties of materials, Hooke's law, modulus of elasticity, tension test on ductile and brittle materials, factor of safety, allowable stress, Stresses and deformations in tapered bars, stepped bars, Poisson's ratio, shear stress and shear strain, modulus of rigidity, relation between modulus of elasticity, modulus of rigidity and bulk modulus, application problems. (9 hours)

Statically indeterminate members: Compound bars, thermal stress. (6 hours)

Stresses in thin cylinder: Hoop, longitudinal and shear stresses. Change in dimensions due to the fluid pressure, joint efficiency and application problems. (3 hours)

Text/Reference:

- Meriam & Kraige, Engineering Mechanics, John Wiley & Sons.
- Beer & Johnston, Vector Mechanics for Engineers, Tata McGraw Hill.
- Singer F.L., Engineering Mechanics, Harper & Row.
- E. P. Popov, Mechanics of Materials, S.I. Version, PHI.
- Pytel and Singer, Strength of Materials, Harper & Collins.
- I.H.Shames – Engineering Mechanics – Statics & Dynamics II Edn. (SI Version) – Prentice Hall.
- S.P. Timoshenko and D.H. Young – Engineering Mechanics – Mc Graw Hill.
- Bhavikatti & Rajasekharappa, Engineering Mechanics, New Age International.
- Bhavikatti S.S., Strength of Materials, Vikas Publishers.
- Basavarajaiah & Mahadevappa, Strength of Materials, CBS Publishers.

PROBLEM SOLVING USING COMPUTERS

ICS 111 3 - 1 - 3 - 5

Introduction to Computing: Introduction, Computer Organization, early Operating System, Machine, Assembly and High-Level language, History of C, Typical C program development environment, Problem solving using computers, Idea of Algorithm: steps to solve logical and numerical problems, Representation of Algorithm, Flowchart/Pseudocode with examples, Simple C programs, Syntax and Logical Errors in compilation, object and executable code. (6 hours)

C language: Types, operators, expressions and control flow. Variable names and declarations, Datatypes, sizes and constants. Arithmetic operators, relational and logical operators, increment and decrement operators and bitwise operators. Type conversion, assignment operators and expression, conditional expressions, precedence and order of evaluation. Statements and blocks, IF-ELSE, ELSE-IF, SWITCH, LOOPS-WHILE, DO-WHILE and FOR, Break and continue statements. (14 hours)

Arrays and Strings: 1-D arrays and strings, searching: Linear and binary searching. Comparison between search procedures. Programs on strings and string handling functions. Sorting: Selection, bubble. Comparison between sorting procedures. Sorting with strings. Multidimensional arrays and matrices. (12 hours)

Modular programming and recursive functions: Functions: The prototype declarations. Actual and formal parameters, function definition. Function call: Pointer variables, Declaration and dereferencing pointer variables. Passing arguments to a function, by value, by reference. Functions with and without returns, Scope of variables, Recursive programming, as a different way of solving problems. (12 hours)

More data types in C and others – Structures: Defining structures and Array of Structures. Pointers: Pointer arithmetic. Pointer to structures. (4 hours)

Text/Reference:

- Dromey.R. G, How to solve it by computers, Pearson, 1982.
- Balagurusamy.E, Computing fundamentals and C programming (1e), McGraw-Hill, 2008.
- Deital.P. J and Deitel.H.M, C: How to program (7e), Pearson Education, 2010.
- Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson Education, 1988.

PROBLEM SOLVING USING COMPUTERS LABORATORY

Introduction to computing and programming IDE, Simple Programs, Variables, Operators, Branching, control structures, Looping control structures, 1D Array, Strings, Sorting, 2D Array Modular programming, Recursive functions, Pointers, Structures.

Text/Reference:

- Balagurusamy.E, Computing fundamentals and C programming (1e), McGraw-Hill, 2008.
- Deital.P. J and Deitel.H.M, C: How to program (7e), Pearson Education, 2010.

A COURSE ON PSYCHOLOGY FOR ENGINEERS

IHS 111 — 3 - 0 - 0 - 3

Introduction to Psychology: The Philosophical origin of Psychology, Modern schools of Psychology, Scope of Psychology and important methods. (4 hours)

Learning: Classical conditioning, Operant conditioning, learning by observation. (4 hours)

Intelligence: Intelligence – theories of Intelligence, Assessing intelligence, Emotional intelligence. (3 hours)

Perception and attribution: Definitions, factors influencing perception, perceptual organization, theories of attribution. (3 hours)

Personality: Psychodynamic approach, Trait approach, Behavioural and Humanistic approach, Assessment of personality. (4 hours)

Introduction to Industrial/Organizational Psychology: Evolution; Contributions of F W Taylor, F Gilbreth and Elton Mayo, Scope of Industrial/Organizational Psychology, Limitations of Industrial Psychology; Research Methodology. (5 hours)

Managerial Psychology: Types of human occupation, Business and Profession, Classification of Industries; Manager and Management, Classification of managers, Functions of managers, Principles of management, Types of planning and plans. (5 hours)

Human Relations Psychology: Behavioural management theories-Abraham Maslow, Herzberg and McGregor; Leadership Styles and Leadership Grid. (3 hours)

Consumer Psychology: Types of markets and products, Selling and marketing, Role of marketing, Functions of marketing; Market segmentation, Marketing mix, Product Life Cycle and marketing strategies; Data collection methods. (5 hours)

Text/Reference:

- Feldman, R. S. (1993), Understanding psychology, New York: McGraw-Hill.
- Myers, D. G. (2005), Exploring psychology, New York, NY: Worth Publishers.
- Morgan and King (Latest edition) Introduction to Psychology, New York: McGraw-Hill.
- Paul E. Spector (2016), Industrial and Organizational Psychology: Research and Practice", Wiley.
- Michael G. Aamodt (2013), Industrial Psychology, Cengage.
- May Smith (2007), An Introduction To Industrial Psychology, Read Books.
- Naylor J. C and Blum M. L (2003), "Industrial Psychology: Its Theoretical and Social Foundations", CBS.

COMMUNICATION SKILLS IN ENGLISH

IHS 112 — 3 - 0 - 0 - 3

Listening: Audio and Video talks and response to each of them. (4 hours)

Speaking: Speech and Presentation techniques /Group Discussion. (10 hours)

Reading: Different styles, kinds of narratives and forms. (8 hours)

Earnest Hemmingway – The Old Man and the Sea (Text for Reading).

Strategies: skimming, scanning and critical analysis

Grammar: Sentence structures: error identification and correction. (4 hours)

Writing:

Paragraph writing

Essay writing:

Argumentative
Narrative
Expository

Editing:

Summary writing
Statement of purpose
Resume' (10 hours)

Text/Reference:

- Stanley Fish, How to write a sentence: And how to Read one, HarperCollins, New York, 2005.
- Raymond Murphy, Essential English Grammar: A Self-Study reference and Practice Book, Cambridge University Press, 2001.
- William Strunk and E B White, The elements of style, Longman, New York, 1999.
- Paul Eschholz and Alfred Rosa, Outlooks and Insights: A Reader for Writers, St Martin's Press, 1995.

ENGINEERING GRAPHICS - I

IME 111 **0 - 0 - 3 - 1**

Software: AutoCAD

Introduction: Introduction to engineering graphics, Geometrical constructions, Dimensioning and conventions of lines.

Projection of Points: Introduction to orthographic projection, Meaning of reference planes, Quadrants, Types of quadrants, Conventional representation of first angle projection system. Projection of points in first angle projection system only.

Projection of Straight Lines: Line parallel to both reference planes, Perpendicular to reference plane, Inclined to one reference plane, Inclined to both reference planes including locating traces, finding true length and inclinations.

Projection of Plane Surfaces: Simple planes (Triangle, Square, Rectangle, Pentagon, Hexagon &Circle), Plane resting on edge and corner conditions, Surface inclined to HP & perpendicular to VP, Surface inclined to VP and perpendicular to HP, Simple cases of planes inclined to both HP & VP (Change of position method only).

Projection of Solids: Simple solids like prisms & pyramids (Triangle, Square, Rectangle, Pentagon & Hexagon), Cone and cylinder, Solids resting on edge and corner conditions, Axis inclined to HP and parallel to VP, Inclined to VP & parallel to HP. Simple cases of axis inclined to both HP and VP (Change of position method only).

Text/Reference:

- Gopalkrishna K. R. and Sudhir Gopalkrishna (2012) "A textbook of Computer Aided Engineering Drawing", 37th Edition, Subhas Stores, Bangalore.
- Bhat N. D. and V.M. Panchal (2010) "Engineering Drawing", 50th Edition, Charotar Publishing House, Anand, India.
- Venugopal K. (2002) "Engineering Drawing and Graphics + Auto CAD" Newage International Publishers, Delhi.
- Narayana K. L. and Kannaiah P (2002) "Text book on Engineering Drawing" Scitech Publications, Chennai.
- Basant Agrawal & Agrawal C M (2010) "Engineering Drawing" Tata McGraw Hill, New Delhi.

B.Sc. (COMPUTER SCIENCE & ENGINEERING)

II SEMESTER

MATHEMATICS - II

IMA 121 **3 - 1 - 0 - 4**

Multiple integrals: double and triple integrals, change of order of integration, Jacobian of polar, cylindrical and spherical coordinate systems, change of variables, Application of multiple integrals to find area and volumes. Curvilinear coordinates systems-Spherical and cylindrical coordinate systems. (14 hours)

Vectors - Vector differentiation, Divergence, Gradient and Curl and their physical interpretation and simple applications. Vector integration, Greens theorem in the plane, Gauss Divergence theorem. (10 hours)

Linear algebra: n-dimensional vectors, vector spaces, linear combination, linear dependence, linear independence, spanning set, basis, Norms, Inner Products, Lengths and Distances Gram-Schmidt orthogonalisation process. Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. (14 hours)

Linear system of equations: Rank of a matrix, Elementary row operations, Gauss elimination process, consistency, Inverse of invertible matrices by row operations. Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization. (10 hours)

Text/Reference:

- Calculus and Analytical Geometry - IV Edn. - George B. Thomas Jr. (1992) Addison Wesley Publications.
- Calculus & Analytical Geometry - George B. Thomas Jr & Ross L. Finney (1998), Addison Wesley Publications.
- Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
- David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
- Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016), Wellesley-Cambridge Press.
- Theory and problems of vector Analysis and an introduction to tensor analysis, Murray R. Speigel and others (2011), Tata McGraw Hill Publications.
- Higher Engineering Mathematics, Grewal B. S., Grewal J. S. (2015), Kanna Publishers.

PHYSICS - II

IPH 121 **3 - 0 - 3 - 4**

Electric Fields: Coulomb's law, The electric field, Continuous charge distribution, Charged particles in uniform electric field. (3 hours)

Gauss's Law: Gauss's law and derivation, Applications to various charge distributions, Conductors in electrostatic equilibrium. (3 hours)

Electric Potential: Potential difference in uniform electric field, Potential and energy due to point charges, Electric field and potential, Continuous charge distributions, Potential due to charged conductor, Applications of electrostatics. (4 hours)

Capacitance and Dielectrics: Calculating capacitance, Combinations of capacitors, Energy in a charged capacitor, Capacitors with dielectrics, Dipole in electric field, Atomic description of dielectrics. (3 hours)

Current and Resistance: Electric current, Resistance, Electrical conduction, Resistance and temperature, Superconductors, Electrical power. (3 hours)

Direct Current Circuits: Electromotive force, Resistors in series and parallel, Kirrchhoff's rules, RC circuits, Electrical meters. (3 hours)

Magnetic Fields: Magnetic fields and forces, Magnetic force acting on a current-carrying conductor, Torque on a current loop in a uniform magnetic field, Motion of a charged particle in uniform magnetic field, Applications, Hall effect. (3 hours)

Sources of the Magnetic Field: The Biot-Savart law, The magnetic force between two parallel conductors, Ampere's law, The magnetic field of a solenoid, Magnetic flux, Gauss's law in magnetism, Displacement current and the general form of Ampere's law, Magnetism in matter. (4 hours)

Faraday's Law: Faraday's law of induction, Motional emf, Lenz's law, Induced emf and electric fields, Generators and motors, Eddy currents, Maxwell's equations. (3 hours)

Inductance: Self-inductance, RL circuits, Energy in a magnetic field, mutual inductance, Oscillations in an LC circuit, The RLC circuit. (3 hours)

Alternating Current Circuits: AC sources, Resistors in an AC circuit, Inductors in an AC circuit, Capacitors in an AC circuit, The RLC series circuit, Power in an AC circuit, Resonance in a series RLC circuit, The transformer and power transmission, Rectifiers and filters. (4 hours)

Text/Reference:

- Serway & Jewett; Physics for Scientists and Engineers with Modern Physics; Volume 2; 6e, Thomson.
- Halliday, Resnick, Krane; Physics; Volume 2; 5e, John Wiley and Sons, Inc.

PHYSICS LABORATORY

To perform any 12 of the following experiments:

1. Field along the axis of a coil
2. Energy band gap of a semiconductor
3. Newton's rings
4. Blackbody radiation
5. Photoelectric effect
6. Charging and discharging of a capacitor / RC time constant
7. Series and parallel resonance circuits
8. e/m –Thomson's method
9. Fermi energy of a metal
10. Hall effect
11. Zener diode characteristics
12. Hysteresis loss in magnetic materials
13. Half wave and full wave rectifier circuits, C-filter circuit
14. Resistivity of a semiconductor by four probe method

CHEMISTRY

ICH 121 3 - 0 - 0 - 3

Electrochemistry: Introduction to electrochemical cell and its types, Liquid junction potential, EMF of the cell and its determination, Standard cell, Origin of electrode potential, Single electrode potential, Nernst equation for electrode potential, Types of electrodes-hydrogen electrode, Calomel electrode and glass electrode, Numericals. (5 hours)

Chemical equilibrium: Introduction to chemical equilibrium, Laws of mass action. Relation between K_c and K_p, L_e-Chatelier principle and its application.

Ionic equilibria: Arrhenius theory of electrolyte dissociation, The Ostwald dilution law, Ionic product of water, hydrolysis, hydrolysis of salts of four types, hydrolysis constant, relation between K_h, K_a/ K_b and K_w, degree of hydrolysis, Common ion effect, solubility product and its applications, Numericals. (4 hours)

Thermodynamics: Terminology of thermodynamics. First law of thermodynamics, Internal energy, Enthalpy, Heat capacity, heat capacity equations at constant volume and pressure, Calculation of ΔU, ΔH and w for reversible isothermal expansion of an ideal gas, Thermochemistry - Hess's law and its applications, Limitations of first law. Second law of

thermodynamics, Concept of entropy. Entropy change - in isothermal expansion of an ideal gas, in reversible and irreversible processes, with change of phase, Physical significance of entropy, Helmholtz Free Energy, Gibbs free Energy, Gibbs Helmholtz equation, Numericals. (5 hours)

Chemical Kinetics: Rate of a reaction, order and molecularity of a reaction, rate law, integrated rate equation and half-life (first and second order reaction), energy of activation, theories of reaction rates-collision theory and transition state theory, Numericals. (4 hours)

Chemical bonding: Primary bonding, Ionic bond, Ionic bond formation, Factor influencing the formation of ionic bond, Lattice energy & its determination by Born-Haber cycle, Properties of ionic bond.

Covalent bond: Covalent bond formation, valence bond theory, Molecular orbital theory & their application to diatomic molecules, Concept of resonance, Valence shell electron pair repulsion concept (VSEPR), Properties of covalent bond.

Metallic bond: Structure of metals, Electron sea model, band theory of solids, conductors, semiconductors & insulators, Properties of metallic bond.

Secondary bonding: Hydrogen bond, Conditions of formation & types of hydrogen bonding with illustrative examples, Vander Waals forces. (10 hours)

Organic reactions and mechanisms: Classification of organic compounds, IUPAC system of Nomenclature, Organic reactions and their Mechanisms-Homolytic and heterolytic fission, carbonium ions, carbanions, carbon free radicals, substitution reactions, addition reactions, elimination reactions, rearrangement reactions, Isomerism - structural and stereoisomerism. (8 hours)

Text/Reference:

- Atkins P W, Physical chemistry, 8th Edn, Oxford University Press, Oxford, 1998.
- Levine IraN, Physical chemistry, 6th Edn, McGraw Hill, New York , 1998.
- James E. Huheey , Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- P.C. Jain, M. Jain, Engineering Chemistry, 15th Edn., Dhanpat Rai and Sons, Delhi, Revised, 2006.
- Arun Bahl and B.S.Bahl, A text book of organic chemistry, 18th edn., S.Chand& Co.ltd, New Delhi, 2006.

DATA STRUCTURES

ICS 121 **3 - 1 - 0 - 4**

Introduction: Accessing variables through pointers, pointer declaration and definition, initialization of pointer variables, pointers for inter function communication, pointers to pointers, Arrays and pointers, pointer arithmetic and arrays, passing an array to a function, memory allocation functions, array of pointers, Type Definition, Enumerated types, Structures, Unions.

Recursion: Algorithm Specification, Introduction, Recursive algorithm, Examples using system stack. (10 hours)

Stacks, Queues: Stacks, Stacks using Dynamic Arrays, Queues, Circular Queues using Dynamic Arrays, Evaluation of Expression, Infix, Postfix and Prefix expressions and their conversions, Multiple stacks and queues, Priority Queues and their Representation, Input/Output Restricted Queues. (10 hours)

Linked Lists: Singly Linked List and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List Operations, Doubly Linked Lists, Circular Linked Lists, Linked Lists with Header Node, Sparse Matrices, Applications using linked lists. (14 hours)

Trees and their Applications: Terminology, Representation of Trees, Binary Trees, Binary Tree Traversals, Additional Binary Tree Operations, Threaded Binary Trees, Binary Search Trees-Definition, Searching a Binary Search Tree, Inserting into and Deletion from Binary Search Tree, Introduction to the concepts of Optimal Binary Search Trees, Red-Black Trees, Multiway Search Trees, B-Trees. (14 hours)

Text/Reference:

- ·Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007.
- ·· Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007.
- Richard F. Gilberg, Behrouz A., Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009.
- Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007.
- Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010.

SWITCHING CIRCUITS AND LOGIC DESIGN

ICS 122 3 - 0 - 0 - 3

Introduction to Logic Circuits: Variables and functions, Inversion, Truth Tables: AND, OR, NOT, NAND, NOR, XOR gates, Boolean algebra, Synthesis using AND, OR and NOT gates, NAND and NOR logic Networks, Introduction to Verilog HDL. (6 hours)

Optimized Implementation of Logic Functions: Karnaugh Map, Strategy for minimization, Minimization of POS forms, Incompletely Specified Functions, Multilevel Synthesis, Multilevel NAND and NOR Circuits. (6 hours)

Arithmetic Circuits: Addition of unsigned numbers, Signed numbers, Arithmetic Circuits: Half Adder, Full Adder, Ripple Carry Adder, Adder/Subtractor, Fast adders-Carry Look Ahead adder, BCD Adder, Design of Arithmetic Circuits using Verilog. (6 hours)

Combinational Circuit Building Blocks: Multiplexer, Decoder, Encoder, Code converter, Arithmetic comparison circuits, Verilog for Combinational Circuits. (6 hours)

Synchronous Sequential Circuits: Flip-Flops, Design of Synchronous Sequential Circuits, Ripple Counters, Registers, Shift Registers, Ring and Johnson Counters, Using Verilog Constructs for Storage Elements. (10 hours)

Switching Circuits: Transistor Switches, NMOS, CMOS Logic Gates, Programmable Logic Devices, Noise Margin, Power dissipation, Transmission Gates, Fan-in, Fan-out in Logic Gates, Tri-state drivers. (2 hours)

Text/Reference:

- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design" Tata McGraw Hill Publishing Co. Ltd., 3rd Edition, 2014.
- M. Morris Mano, "Digital Design", PHI Pvt. Ltd., 2nd Edition, 2000.
- Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Co. Ltd, 2003
- John F. Wakerly, "Digital design - Principles and practice", Pearson Education, 4th Edition, 2013.

COMPUTER ORGANIZATION AND ARCHITECTURE

ICS 123 3 - 0 - 0 - 3

Basic structure of Computers: Computer types, Functional units, Basic operational concepts, Number Representation and Arithmetic Operations, Character Representation, Problems. (4 hours)

Instruction set Architecture: Memory locations and addresses, Memory operations, Instructions and Instruction Sequencing, Addressing modes, CISC Verses RISC Styles, Example Programs. (4 hours)

Arithmetic and Logic Unit: Hardware for addition and subtraction, Multiplication, Hardware implementation, Booth's algorithm, Division, Floating point representation, IEEE standard floating-point representation, Floating point arithmetic. (7 hours)

Processing Unit: CPU structure and Function: processor organization, register organization, Instruction cycle, Control Unit Operation: Micro operations, Control of the processor (exclude Intel 8085), hardwired Implementation, micro-programmed control-Basic concepts, micro instructions, micro programmed control unit, Wilkes control, taxonomy of micro instructions. (5 hours)

Memory Systems: Basic concepts, RAM memories, Read only memories, Memory Hierarchy, Cache memories-mapping functions, Placement strategies, Replacement algorithms, Performance considerations, Virtual memories, Secondary storage. (8 hours)

Input/output Organization: Accessing I/O devices, I/O Device Interface, Program Controlled I/O, An Example of a RISC-Style I/O Program, An Example of a CISC-Style I/O Program, Interrupts, Enabling and Disabling Interrupts, Handling Multiple Devices, Direct Memory Access. (4 hours)

Introduction to parallel Architecture: Pipelining- Basic Concept, Vector (SIMD) Processing, Shared-Memory Multiprocessors, Cache Coherence, Write-Through Protocol, Write-Back protocol, Snoopy Caches. (4 hours)

Text/Reference:

- Carl Hamacher, ZvonkoVranesic and SafwatZaky, “Computer Organization and Embedded Systems”, Sixth edition, McGraw Hill Publication, 2012.
- William Stallings, “Computer Organization and Architecture Designing for Performance”, Tenth edition, Pearson Education Limited, 2016
- D.A. Patterson and J.L.Hennessy, "Computer Organization and Design-The Hardware/Software Interface", Fifth Edition, Morgan Kaufmann, 2011.

DATA STRUCTURES LABORATORY

ICS 124 0 - 0 - 3 - 1

Design, Develop and Implement programs and applications – Using the concepts of pointers, Structures and Recursion. Using the concepts of Stacks and Queues. Using the concepts of Linked Lists. Using binary trees.

Text/Reference:

- Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007.
- Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007.
- Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009.
- Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007.
- Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010.

SWITCHING CIRCUITS & LOGIC DESIGN LABORATORY

ICS 125 **0 - 0 - 3 - 1**

Introduction to Logic gates, Implementation of Boolean functions using gates, Arithmetic circuits, Multiplexers, Decoders, Encoders, Magnitude comparators, Flip Flops and ripple counters, Synchronous counters, Implementation of the above Verilog HDL.

Text/Reference:

- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design" Tata McGraw Hill Publishing Co. Ltd., 3rd Edition, 2014.
- M. Morris Mano, "Digital Design", PHI Pvt. Ltd., 2nd Edition, 2000.
- Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Co. Ltd, 2003.
- John F. Wakerly, "Digital design - Principles and practice", Pearson Education, 4th Edition, 2013.

III SEMESTER

MATHEMATICS III

IMA 231 **3 - 1 - 0 - 4**

Two Basic Counting Principles, Simple Arrangements and Selections Arrangements and Selections with Repetitions, Distributions, Binomial Identities, Generating Function Models, Calculating Coefficients of Generating Functions, Partitions, Exponential Generating Functions. (14 hours)

Basic Set theory, Axioms of probability, Sample space, conditional probability, total probability theorem, Baye's theorem. One dimensional and Two-dimensional random variables, mean and variance, properties, Chebyschev's inequality, correlation coefficient. (10 hours)

Distributions: Binomial, Poisson, Exponential, Normal and Chi-square. (8 hours)

Functions of random variables: One dimensional and Two-dimensional, Moment generating functions. (10 hours)

Optimization: Basic solution, Convex sets and function, Simplex Method, Constrained Optimization. (6 hours)

Text/Reference:

- P.L. Meyer "Introduction to probability and Statistical Applications",2nd edition, 1980, Oxford and IBH publishing, Delhi.
- Miller, Freund and Johnson, "Probability and Statistics for Engineers", 8th Edn., PHI, 2011.
- Ross Sheldon M, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, 2010.
- Alan tucker, Applied Combinatorics, Wiley Publishers, 2012.
- Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
- Hamdy A. Taha, "Operations Research: An Introduction", 8th Edn., Pearson Education (2008).
- E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.

ANALOG ELECTRONIC CIRCUITS

IEC 231 **3 - 1 - 0 - 4**

Bipolar Transistor: Structure of Bipolar Transistor, Operation of Bipolar Transistor in Active Mode: Collector Current, Base and Emitter Currents, Bipolar.

Transistor Models and Characteristics: Large-Signal Model, Small-Signal Model, Early Effect, operation of Bipolar Transistor in Saturation Mode. (6 hours)

BJT Amplifiers: Input and Output Impedances, Biasing: DC and Small-Signal Analysis, Simple Biasing, Resistive Divider Biasing, Biasing with

Emitter Degeneration, Self-Biased Stage, Amplifier Topologies: Common-Emitter, Common-Base, Emitter Follower. (6 hours)

MOS Transistor: Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Trans conductance, MOS Device Models: Large-Signal and Small-Signal Model, PMOS Transistor, Comparison of Bipolar and MOS. (8 hours)

MOS Amplifier: Amplifier Topologies, Biasing, Realization of Current Sources, Common-Source Stage: CS Core, CS Stage with Current-Source Load, CS Stage with Diode Connected Load, CS Stage with Degeneration, CS Core with Biasing, Common-Gate Stage: CG Stage with Biasing, Source Follower: Source Follower Core, Source Follower with Biasing. (8 hours)

Frequency Response: Fundamental Concepts: General Considerations, Relationship Between Transfer Function and Frequency Response, Miller's Theorem, General Frequency Response, High-Frequency Models of Transistors: High-Frequency Model of BJT and MOSFET, Transit Frequency, Frequency Response of CE / CS, CB / CG and Source / Emitter Followers. (6 hours)

Feedback: Loop Gain, Properties of Negative Feedback: Gain Desensitization, Bandwidth Extension, Modification of I/O Impedances, Linearity Improvement, Types of Amplifiers: Simple Amplifier Models, Examples of Amplifier Types, Sense and Return Techniques, Polarity of Feedback, Feedback Topologies: Voltage-Voltage, Voltage-Current, Current-Voltage, Current-Current Feedback. (6 hours)

Oscillators: General Considerations, Heartley and Colpitts Oscillator, Phase Shift Oscillator, Ring Oscillator. (4 hours)

Power Amplifier: General Considerations, Different Classes of Power amplifiers, Class A amplifier, Class B amplifier and Class AB amplifer, Power efficiency of all Classes. (4 hours)

Text/Reference:

- Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
- A. S. Sedra, K. C. Smith, "Microelectronic circuits", Oxford University Press, 2011.
- R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 2009.
- J. Millman, C. C. Halkias, Chetan. D. Parekh, "Integrated Electronics", McGraw Hill. 2010.

DATABASE MANAGEMENT SYSTEMS

ICS 231 **3 - 0 - 0 - 3**

Introduction: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators, NoSQL, Sharding.

Relational Model: Structure of Relational Databases, Database Schemas, Keys, Schema Diagrams, Relational Query Languages, Relational Operations, Relational Algebra –Fundamental Operations, Formal Definition of Relational Algebra, Extended Relational Algebra Operations. (7 hours)

Structured Query Language: SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Nested Subqueries, Additional Basic Operations Null Values, Modification of the Database. Join Expressions, Views, Transactions. (8 hours)

Database Design Using E-R Model: : Overview of the Design Process, The Entity-Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity- Relationship Diagrams, Entity-Relationship Design Issues, Extended E-R Features, Reduction to Relational Schemas.

Normalization: Features of Good Relational Design, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional Dependency Theory, Algorithms for Decomposition, Decomposition Using Multivalued Dependencies. (10 hours)

Indexing and Hashing: File Organization, Organization of Records in Files, Basic concepts, Ordered Indices, B+ Tree Index Files, B+ Tree Extensions, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing. Bitmap Indices.

Transaction Management: Transaction Concept, A simple Transaction model, Transaction Atomicity and Durability, Transaction Isolation, Serializability, Transaction Isolation and Atomicity, Transaction Isolation Levels, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

(11 hours)

Text/Reference:

- Silberschatz, Korth, Sudarshan, Database System Concepts, (6e), McGrawHill, New York, 2011.
- Pramod J Sadalage, Martin Fowler, NoSQL Distilled, Addison-Wesley, 2013.
- Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, Fundamentals of Database Systems, (6e), Pearson Education, United States of America, 2011.
- Thomas Connolly, Carolyn Begg, Database Systems – A Practical Approach to Design, Implementation and Management, (4e), Pearson Education, England, 2005.
- Peter Rob, Carlos Coronel, Database Systems–Design, Implementation and Management, (10e), Course Technology, Boston, 2013.

SOFTWARE DESIGN USING OBJECT ORIENTED PARADIGM

ICS 232 **3 - 0 - 0 - 3**

Introduction: Procedure and Objected oriented systems, Need for Object Oriented systems, OO Development, OO themes, Modeling, Abstraction, Three Models, Object and Class concepts. (3 hours)

Object oriented Paradigms in Java: Introduction to Java language, Introduction to Classes and Objects in Java, Methods in Java, Inheritance in Java, Interfaces in Java, Packages in Java. (6 hours)

Structural Modeling: Class and Object Concepts – Enumerations, Multiplicity, Scope, Visibility, Link and Association – Association ends, N-ary association, Aggregation versus Association, Aggregation versus Composition, Operations, Abstract Classes, Generalization - Nested Generalization, Metadata, Inheritance - Types, Multiple Inheritance, Reification, Constraints, Derived Data, Packages, Sample model and navigation. (7 hours)

Interaction Modeling: Use case models – Actors, Use Cases, Use Case Diagrams, Use Case Relationships – Include, Extend, Generalization, Combination and Guidelines of Use case relationships.

Sequence Models – Scenario, Sequence diagrams, Diagrams with passive and transient objects, Guidelines.

Activity Models – Activities, Branches, Initiation, Termination, Concurrent activities, Executable, Signals - send and receive, Swimlanes, Flows, Guidelines. (12 hours)

Domain Analysis: Domain Class model, Domain State Model, Domain Interaction Model, Application Interaction Model, Class Model, Operations .

(3 hours)

State Modeling: Events, States, Transitions and Conditions, State Diagrams and behavior, Nested State diagrams, Nested States, Signal Generalization, Concurrency, Sample State Model, Relation of Class and State Model. (3 hours)

Grasp Patterns: Introduction to Patterns, why are they required, Types - Structural, Behavioral, Creational, Designing objects with responsibilities – Creator, Information expert, Low Coupling, High Cohesion, Controller. (2 hours)

Text/Reference:

- Object-Oriented Modeling and Design with UML, Second Edition, Michael R Blaha, James R Rumbaugh, Pearson, 2013.
- Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", Third Edition, Pearson Education, 2005. Reprint 2015.

- Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", Third edition, AddisonWesley, 2003.
- Herbert Schildt and Dale Skrien, Java Fundamentals – A Comprehensive Introduction, (1e), McGrawHill, 2015.

DATABASE MANAGEMENT SYSTEMS LABORATORY

ICS 233 **0 - 0 - 6 - 2**

The experiments and mini project are based on following topics:

MS Access, Introduction to SQL, Intermediate SQL, Integrity Constraints in SQL, Additional Exercises on SQL, PL/SQL Basics, Exception Handling and Cursors, Additional Cursors constructs and Transactions, Procedures, Functions and Packages, Triggers.

Text/Reference:

- Silberschatz, Korth, Sudarshan, Database System Concepts, (6e) McGrawHill, 2011.
- Ivan Bayross, SQL, PL/SQL, (3e), BPB Publications.
- G, Reese, Database Programming with JDBC And Java, (2e), O'REILLY, 2000.

SOFTWARE DESIGN USING OBJECT ORIENTED PARADIGM LABORATORY

ICS 234 **0 - 0 - 3 - 1**

Classes in Java – control access to members, this reference, default and no-argument constructors, set and get methods, static class members, static members, final instance variable, package access. Inheritance – Superclasses and Subclasses, Constructors in subclasses, Class object, Composition vs. Inheritance. Polymorphism and Interfaces – Polymorphism examples, Abstract classes and methods, final Methods and Classes, creating and using interfaces, private Constructors. Requirement elicitation for a given problem, create use case diagram, activity diagram, sequence diagram, collaboration diagram, Domain class and detailed class diagram of the given system, create a state chart diagram for each of the classes identified, 2 full case studies – POS and ATM.

Text/Reference:

- Herbert Schildt and Dale Skrien, Java Fundamentals – A Comprehensive Introduction, (1e), McGrawHill, 2015.
- Dietel and Dietel, Java How to Program, (9e), Prentice Hall India, 2012.
- Herbert Schildt, The Complete Reference JAVA 2, (10e), Tata McGrawHill, 2017 .
- Steven Holzner, Java 2 Programming Black Book, DreamTech, India, 2005.
- Bruce Eckel, Thinking in Java, (5e), Prentice Hall, 2013.

INTRODUCTION TO DATA ANALYTICS WITH PYTHON

ICS 235 **2 - 1 - 0 - 3**

Basics of data analysis with Python: Introduction to Data Science with Python: The Stages of Data Science, Why Python? Python Environment and EditorsThe Basics of Python Programming, Fundamental Python Programming Techniques, Data Cleaning and Manipulation Techniques, Abstraction of the Series and Data Frame, Running Basic Inferential Analyses. The Importance of Data Visualization in Business Intelligence: Shifting from Input to Output, Why Is Data Visualization Important?, Why Do Modern Businesses Need Data Visualization?, The Future of Data Visualization, How Data Visualization Is Used for Business Decision-Making, Introducing Data Visualization Techniques. Data Collection Structures: Lists, Dictionaries, Tuples, Series, Data Frames, Panels. File I/O Processing and Regular Expressions: File I/O Processing, Regular Expressions. Data Gathering and Cleaning: Cleaning

Data, Reading and Cleaning CSV Data, Merging and Inte-grating Data, Reading Data from the JSON, HTML, XML Format. Data Exploring and Analysis: Series Data Structures, Data Frame Data Structures, Data Analysis. (16 Hours)

Data Visualization: Direct plotting: Line Plot, Bar Plot, Pie Chart, Box Plot, Histogram Plot, Scatter Plot Seaborn Plotting System: Strip Plot, Swarm Plot, Box plot, Joint Plot.

Matplotlib Plot: Line Plot, Bar Plot, Pie Chart, Stack Plot, Histogram Plot, Scatter Plot Case studies. (6 hours)

Data Exploration: Scalars, Vectors, and Spaces, Dealing with Counts, Binarization, Quantization or Binning, Log Transformation, Log Transform in Action, Power Transforms: Generalization of the Log Transform, Feature Scaling or Normalization, Min-Max Scaling, Standardization (Variance Scaling), l2 Normalization, Interaction Features.

Feature Selection, Encoding Categorical Variables, One-Hot Encoding, Dummy Coding, Effect Coding, Pros and Cons of Categorical Variable Encodings, Dealing with Large Categorical Variables, Feature Hashing, Bin Counting. (8 hours)

Regression Clustering And Classification: Relationships between variables: Regression Multivariate Linear Regression Ordinary Least Squares Brain and Body: Regression with one variable Logarithmic transformation Making the Task Easier: Standardization and Scaling Polynomial Regression Variance-Bias Trade-Off Shrinkage: LASSO and Ridge, Clustering, Clustering with K-Means, Classification, Classification with KNN. (6 hours)

Text/Reference:

- Dr. Ossama Embarak, Data Analysis and Visualization Using Python, Apress, 2018.
- Alice Zheng and Amanda Casari The Feature Engineering for Machine Learning O' Reil-ley publishers 2018.
- Jesus Rogel-Salazar Data Science and analytics with python, CRC Press 2018.
- Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Explor-atory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
- Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publica-tion, 2009.

ARTIFICIAL INTELLIGENCE

ICS 236 **3 - 0 - 0 - 3**

Introduction: What is AI? Definitions of AI and its's four categories , Turing test, Foundations of Artificial Intelligence, History of Artificial Intelligence, The state of the Art. (4 hours)

Intelligent Agents: Introduction, Agents action, mapping from percept sequences to actions, Agents and Environments, Rationality logic, The Nature of Environments, Rational Agent, Structure of intelligent agents: Agent programs Simple reflex agents, model-based, goal-based agents, utility-based agents and learning agents, behavior and environment in which a particular agent operates, properties of agents. (3 hours)

Solving problems by searching: Problem solving and search Techniques: Defining the problem as a state space Search State space representation, production systems, problem characteristics, production system characteristics, Uninformed Search: Breadth First Search, Depth First Search, Depth-limited search and Iterative deepening DFS, Uniform cost search.

Heuristic Search Techniques: Best First Search, A* algorithm, Constraint Satisfaction Problem, Means-End Analysis, Adversarial search: Min-Max search procedure, Alpha – Beta pruning. (10 hours)

Logical Agents: Knowledge based agents, The Wumpus World environment, specifying the environment, acting and reasoning in Wumpus world, representing reasoning and logic: Logic, Propositional logic, Propositional Theorem Proving, Agents based on propositional logic. (4 hours)

Using Predicate Logic: Representing simple facts in logic, Representing instances and ISA relationship, Compatible functions and predicates. (4 hours)

Knowledge Representation: Ontological Engineering, knowledge representation using predicate calculus, Knowledge engineering process. Representing knowledge using rules: Procedural versus Declarative knowledge, Forward versus Backward reasoning. (6 hours)

Quantifying uncertainity and probabilistic Reasoning: Acting under uncertainty, Basic probability notation, Inference using full joint distribution, Probability and Bayes' theorem, knowledge engineering for uncertain domain, Semantics and inference of Bayesian belief networks, Semantic nets and Frames, Forward and backward chaining algorithms. (5 hours)

Text/Reference:

- Stuart Russell and Peter Norvig – Artificial Intelligence A Modern Approach, Pearson Education, Third Edition, 2016.
- Elaine Rich, Kevin Knight,Shivashankar B. Nair, Artificial Intelligence, Third Edition, Tata McGraw Hill Edition, 2010
- Saroj Kaushik– Artificial Intelligence, Cengage Learning Publications, First Edition, 2011.
- Don W. Patterson - Introduction to Artificial Intelligence and Expert Systems, PHI Publication,2006.

MACHINE LEARNING

ICS 237 **3 - 0 - 0 - 3**

Introduction and Supervised Learning Basics: Towards Intelligent Machines, Well-Posed Machine Learning Problems, Examples of Applications in Diverse Fields, Forms of Learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning.

Learning from Observations, Bias and Variance, Computational Learning Theory, Occam's Razor Principle and Overfitting Avoidance, Metrics for Assessing Regression Accuracy, Metrics for Assessing Classification Accuracy, An Overview of the Design Cycle and Issues in Machine Learning.

(6 hours)

Statistical Learning: Bayesian Reasoning: Bayes Theorem, Naïve Bayes Classifier, Bayesian Belief Networks, k-Nearest Neighbour Classifier, Discriminant Functions and Regression Functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks Parametric Methods: Introduction, Maximum Likelihood Estimation, The Bayes Estimator. (8 hours)

Support Vector Machines: Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Linear Maximal Margin Classifier for Linearly Separable Data, Linear Soft Margin Classifier for Overlapping Classes, Regression by Support Vector Machines: Linear Regression, Nonlinear Regression. (6 hours)

Data Clustering: Unsupervised Learning, Engineering the Data, Overview of Basic Clustering Methods, K-Means Clustering, Expectation-Maximization Algorithm and Gaussian Mixtures Clustering, Hierarchical Clustering. (7 hours)

Decision Trees: Introduction, Example of a Classification Decision Tree, Measure of Impurity for Evaluating Splits in Decision Trees, ID3, C4.5, and CART Decision Trees, Pruning the Tree, Strengths and Weaknesses of Decision Tree Approach.

(7 hours)

Combining Multiple Learners: Rationale, Generating Diverse Learners, Voting, Error-Correcting Output Codes, Bagging, Boosting. (2 hours)

Text/Reference:

- M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018.
- Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press. 2010.
- Peter Harrington, Machine Learning in Action, Manning Publications, 2012.
- Andreas C. Müller & Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media Inc., 2017.
- Tom M Mitchell, Machine Learning, McGraw Hill, 2017.

IV SEMESTER

SIGNALS AND SIGNAL PROCESSING

IEE 241 **3 - 1 - 0 - 4**

Introduction to Signals and Systems: Definitions of signals and systems, classification of signals, basic operations on signals, elementary signals and functions, systems viewed as interconnections of operations, properties of systems. (8 hours)

Time domain representations for linear time-invariant (LTI) systems: Introduction, convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems. Block diagram representations. (8 hours)

Fourier representations for signals: Introduction, Discrete-time periodic signals: The discrete-time Fourier series, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals: The discrete-time Fourier transform, continuous-time non-periodic signals: The Fourier transform, properties of Fourier representations (Including Parseval's relations). (12 hours)

Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier transform representations for periodic signals, Sampling Theorem, Reconstruction of continuous-time signals from samples. (4 hours)

Z-Transform: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform (Using Partial fraction method), Transform analysis of LTI systems. (8 hours)

Frequency Response of Analog Filters: Frequency response of an LTI system, Butterworth filters, Chebyshev filters (Qualitative discussion). (2 hours)

Digital Filters: Relation between DTFT and Z-transform, Discrete Fourier Transform (DFT), N-point DFT computation. Introduction to digital filters: Finite impulse response (FIR) and infinite impulse response (IIR) filters, Ideal frequency responses of frequency selective filters. (6 hours)

Text/Reference:

- Simon Haykin & Barry Van Veen, (2005), "Signals and Systems", John Wiley & Sons, New Delhi.
- Proakis J.G and Manolakis D.G.Mimitris D. (2003) "Introduction to Digital Signal Processing" Prentice Hall, India.
- H.Hsu, R. Ranjan (2006) "Signals and Systems", Schaums's outline, Tata McGraw – Hill, New Delhi.
- B.P.Lathi., (2005), "Linear systems and Signals", Oxford University Press.

EMBEDDED SYSTEMS

ICS 241 **3 - 0 - 0 - 3**

Introduction To Embedded Systems And Arm Cortex-m Microcontroller: Introduction to Embedded Systems, Microprocessors and Microcontrollers, An overview of ARM-Cortex- M Architecture: General purpose registers, ARM memory map, Load store instructions in ARM, ARM CPSR, ARM Data format, Pseudo instructions and Directives, Introduction to ARM Assembly Programming, The Program Counter and Program Memory space in the ARM, Some ARM Addressing modes, RISC Architecture in ARM. (5 hours)

Arithmetic and Logical instructions, Branch, Call and Looping in Arm: Arithmetic Instructions, Logic Instructions, Rotate and Barrel Shifter, Shift and Rotate Instructions, BCD and ASCII Conversion, Looping and Branch Instructions, Calling Subroutine and Return, Conditional execution, Recursion, Conditional Execution. (10 hours)

Arm Memory Map, Memory Access and Stack: ARM Memory Map and Memory Access, Advanced Indexed Addressing Mode, Stack and Stack usage in ARM, ADR, LDR and PC Relative addressing. (4 hours)

Input/Output (IO) Programming: Pin connect block, Pin function select registers, General Purpose Input and Output (GPIO) registers, GPIO configuration, GPIO programming using ARM C language, Interfacing: LEDs, Seven segment, LCD, keyboard (8 hours)

Timer Programming: Timer versus counter, timer registers, timer architecture and operation, PWM timer and architecture, PWM programming (5 Hours)

Interrupt Programming: Hardware and software synchronization, multithreading, Nested Vectored Interrupt Controller (NVIC), external hardware interrupts, IO interrupts (4 hours)

Text/Reference:

- Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Shujen Chen, ARM Assembly Language Programming & Architecture (2e), MicroDigitalEd, 2016.
- Jonathan W. Valvano., Embedded systems: Introduction to ARM(R) Cortex-M Microcontrollers (5e), Createspace Independent Publishing Platform, June 2014.
- Jonathan W. Valvano., Embedded systems: Real-time interfacing to ARM Cortex-M Microcontrollers (4e), Createspace Independent Publishing Platform, 2017.
- UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 4.1, 2016.
- Toulson and Tim Wilmshurst., Fast and Effective Embedded System Design applying the ARM mbed, Elsevier, 2017.
- Joseph V., A definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors (3e), Elsevier, 2014.

OPERATING SYSTEMS

ICS 242 **2 - 1 - 0 - 3**

Introduction: What Operating Systems Do, Operating System Structure, Operating System Operations, Process Management, Memory Management, Storage Management.

Operating System Structure: Operating System Services, User and Operating System Interface, System Calls, Types of System Calls, System Programs, Operating System Structure, Virtual Machines, System Boot.

Processes: Overview, Process Scheduling, Operations on Processes, Inter-process Communication.

Threads: Overview, Multithreaded Models, Thread Libraries. (10 hours)

Process Synchronization: Background, The Critical Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores.

Cpu Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Linux scheduling.

Deadlocks: System Model, Deadlock, Characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock Avoidance. (10 hours)

Main Memory: Logical Versus Physical Address Space, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of Page Table. VIRTUAL MEMORY: Background, Demand Paging, Copy-On-Write, Page Replacement, Allocation of Frames, Thrashing.

Mass Storage Structure: Disk Structure, Disk Scheduling, Directory and Disk Structure, Disk Management, Swap-Space Management. (10 hours)

File-system Interface: File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection.

Protection: Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix Implementation of Access Matrix. (6 hours)

Text/Reference:

- Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, (9e), Wiley and Sons (Asia) Pte Ltd, 2013.
- Milan Milenkovic, Operating systems: Concepts and Design, McGraw Hill, New York, 1987.
- H. M. Dietel, An Introduction to Operating Systems, Addison Wesley, 1990.
- Andrew S. Tannebaum, Operating System: Design and Implementation, (3e), Prentice Hall of India, 2008.
- Maurice J Bach, Design of Unix Operating System, Prentice Hall of India, 1988.

DESIGN & ANALYSIS OF ALGORITHMS

ICS 243 **2 - 1 - 0 - 3**

Introduction: Introduction, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental Data Structures.

Fundamentals of the analysis of algorithm efficiency: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms. (8 hours)

Brute Force: Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search Method, Depth First Search, Breadth First Search.

Decrease and Conquer: Insertion Sort, Topological Sorting, Binary Search. (10 hours)

Divide and Conquer: Mergesort, Quicksort, Binary tree traversals and related properties, Multiplication of large integers and Strassen's Matrix Multiplication.

Transform and Conquer: Presorting, Balanced Search Trees, Heaps and Heapsort, Problem Reduction. (10 hours)

Space and Time Tradeoffs: Sorting by Counting, Input Enhancement in String Matching, Hashing. Dynamic Programming: The Knapsack Problem and Memory Functions. (8 hours)

Text/Reference:

- Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, India, 2011.
- Ellis Horowitz and Sartaj Sahni, "Computer Algorithms/C++", 2nd Edition, University Press, India, 2007.
- Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, "Introduction to Algorithms", 2nd Edition, PHI, India, 2006.

EMBEDDED SYSTEMS LABORATORY

ICS 244 **0 - 0 - 3 - 1**

Assembly Language Programming in ARM using Keil Software: Data transfer instructions, Arithmetic, Logical and Branch instructions, Code conversion, Packing and unpacking of BCD and ASCII data, Sorting, Searching and Recursion.

Interfacing Exercises using LPC1768 ARM kit: Interfacing of LEDs, LCD, Keyboard, 7 Segment Display and Interrupt programming.

Text/Reference:

- Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Shujen Chen, ARM Assembly Language Programming & Architecture (2e), MicroDigitalEd, 2016.
- Jonathan W. Valvano., Embedded systems: Introduction to ARM(R) Cortex-M Microcontrollers (5e), Create space Independent Publishing Platform, June 2014.
- Jonathan W. Valvano., Embedded systems: Real-time interfacing to ARM Cortex-M Microcontrollers (4e), Createspace Independent Publishing Platform, 2017.
- UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 4.1, 2016.
- Toulson and Tim Wilmshurst., Fast and Effective Embedded System Design applying the ARM mbed, Elsevier, 2017.
- Joseph V., A definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors (3e), Elsevier, 2014.

BIG DATA ANALYTICS

ICS 245 **3 - 0 - 0 - 3**

Introduction to big Data, Hadoop and Spark: Introduction to big data, Distributed computing, and Hadoop, Hadoop ecosystem, Hadoop Distributed File System (HDFS), MapReduce framework, MapReduce applications, Understanding YARN architecture, Exploring Hive, Apache Spark background, Uses for Spark, Programming interfaces to Spark, Submission types for Spark

programs, Input/Output types for Spark applications. (6 hours)

Spark Programming Basics : Anatomy of Spark application, Spark driver, Spark workers and executors, The Spark manager and Cluster manager, Spark applications using the standalone scheduler, Spark applications running on YARN, Deployment modes for Spark applications running on YARN, Introduction to RDDs, Loading data into RDDs, Operations on RDDs. (5 hours)

Recommendation System: The alternating least squares recommender algorithm, Spot checking recommendation, Evaluating recommendation quality, Computing AUC, Hyperparameter selection, Making recommendation. (4 hours)

Prediction with decision Trees: Fast forward to regression, Vectors and features, Training examples, Decision trees and forests, Preparing the data, Decision tree hyperparameters, Tuning decision trees, Categorical features revisited, Random decision forests, Making predictions. (4 hours)

Anomaly Detection with K-means Clustering: Anomaly detection, K-means clustering, Network intrusion, Choosing K, visualization, Feature normalization, Categorical variables, Using labels with entropy, Clustering in Action. (4 hours)

Analyzing Co-occurrence network with Graphx: Parsing KML documents, Analyzing the MeSH major topics and their co-occurrences, Constructing a co-occurrence network with GraphX, Understanding the structure of networks, Filtering out noisy edges, Small world networks. (4 hours)

Estimating risk through Monte-carlo Simulation: Methods for calculating VaR: Variance-Co-variance, Historical simulation, Monte-Carlo simulation, Pre-processing, Determining the factor weights, Sampling: The multivariate normal distribution, Visualizing the distribution of returns, Evaluating the results. (4 hours)

Stream processing and messaging using spark: Spark streaming architecture, DStreams, State operations, Sliding window operations, Structured streaming, Apache Kafka. (5 hours)

Text/Reference:

- Vignesh Prajapathi, Big Data Analytics with R and Hadoop, Packt Publishing, 2013.
- Jeffery Aven, Data Analytics with Spark using Python, Pearson, 2018.
- Sandya Ryza, Uri Laserson, Sean Owen and Josh Wills, Advanced Analytics with Spark (2e), O'Reilly Media Inc., 2017.
- Holden Karau, Andy Konwinski, Patrick Wendell and Matei Zaharia, Learning Spark: Lightning-Fast Big Data Analysis (2e), O'Reilly Media Inc, 2020.
- Tom White, Hadoop: The definitive guide (4e), O'Reilly, 2015.

ARTIFICIAL NEURAL NETWORK

ICS 246 **3 - 0 - 0 - 3**

Introduction: What is a Neural Network? The Human Brain, Models of a Neuron, Network Architectures, Learning Processes, Learning Tasks. (5 hours)

Rosenblatt's Perceptron & Multilayer Perceptron: Rosenblatt's Perceptron, The Perceptron Convergence Theorem, Introduction to Multilayer Perceptron, Some Preliminaries, Batch Learning and On-Line Learning, The Back-Propagation Algorithm, XOR Problem, Heuristics in BP Algorithm Performance, Multilayer Perceptron Applications. (12 hours)

Kernel Methods & Radial-basis Function Networks: Introduction, Cover's Theorem (Separability of Patterns), The Interpolation Problem, Radial-Basis-Function Networks, K-Means Clustering, Recursive Least-Squares Estimation of the Weight Vector, Hybrid Learning Procedure for RBF Networks. (5 hours)

Principal Components Analysis: Introduction, Principles of Self-Organized Feature Analysis, Principal-Components Analysis: Perturbation Theory, Hebbian Based Maximum Eigen filter, Hebbian Based Principal Component Analysis, Case study. (2 hours)

Self-organizing Maps: Introduction, Two Basic Feature-Mapping Models, Self-Organizing Map,

Properties of the Feature Map, Case Study: Pattern Identification. (2 hours)

Dynamically Driven Recurrent Networks: Introduction, Recurrent Network Architectures, Universal Approximation Theorem, Controllability and Observability, Computational Power of Recurrent Networks, Learning Algorithms, Back Propagation Through Time, Real-Time Recurrent Learning. (6 hours)

Recurrent Hopfield Networks: Introduction, Operating Principles of the Hopfield Network, Stability Conditions of the Hopfield Network, Associative Memories, Outer Product Method, Pseudoinverse Matrix Method, Storage Capacity of Memories, Design Aspects of the Hopfield Network. (4 hours)

Text/Reference:

- Simon Haykin, Neural Networks and Learning Machines, 3rd ed, Pearson, Prentice Hall, 2009.
- Ivan Nunes da Silva, Danilo Hernane Spatti, Rogerio Andrade Flauzino, Luisa Helena Bartocci Liboni, & Silas Franco dos Reis Alves, Artificial Neural Networks: A Practical Course, Springer International Publishing, 2017.
- John Paul Mueller & Luca Massaron, Deep Learning For Dummies, Wiley & Sons, Inc., 2019.
- Daniel Graupe, Principles of Artificial Neural Networks, 3rd Edition, World Scientific Publishing, 2013.
- Eugene Charniak, Introduction to Deep Learning, MIT Press, 2018.

DATAWAREHOUSING AND DATA MINING

ICS 247 **3 - 0 - 0 - 3**

Data Warehouse and Online Analytical Processing:

Basic concepts, Data warehouse modeling: Data cube and OLAP, Data warehouse design, usage and implementation, Data generalization, Data cube computation: preliminary concepts and computation methods, Prediction mining in cube space, Multifeature cubes: complex aggregation at multiple granularities, Case Study. (13 hours)

Mining Frequent Patterns, Associations and Correlations:

Basic concepts and a road map, Candidate generation algorithms: Apriori algorithm, Improving the efficiency of Apriori, Mining Frequent Item sets: Using Pattern-Growth approach and vertical data format, Mining closed and maximal patterns, Pattern Evaluation Methods, Pattern mining: a road map, Mining associations: Multilevel and Multidimensional, Mining Rare Patterns and Negative Patterns, Constraint based frequent pattern mining, Mining high-dimensional data and colossal patterns, Case Study. (9 hours)

Classification:

Basic concepts, Decision tree induction, Attribute selection measures, Tree pruning, Scalability and decision tree induction, Rule based classification: using IF-THEN rules for classification, Rule extraction from a decision tree, Rule induction using a sequential covering algorithm, Model evaluation and selection: Metrics for evaluating classifier performance, Holdout method and random sub-sampling, Cross-validation, Bootstrap, Model selection using statistical tests of significance, Techniques to improve classification accuracy: Introducing ensemble methods, Bagging, Boosting and AdaBoost, Random forests, Case Study. (5 hours)

Cluster Analysis:

Cluster Analysis and requirements for Cluster Analysis, Basic Clustering Methods, Partitioning Method: k-Medoids, Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods, BIRCH, Chameleon, Density-Based Methods: DBSCAN, OPTICS, DENCLUE, Grid-Based Methods: STING, CLIQUE, Evaluation of Clustering: Assessing Clustering Tendency, Determining the Number of Clusters, Measuring Clustering Quality, Case Study. (5 hours)

Mining Stream Data:

Mining Data Streams: Methodologies for Stream Data Processing and Stream Data Systems, Stream OLAP and Stream Data Cubes, Frequent-Pattern Mining in Data Streams, Classification of Dynamic Data Streams, Clustering Evolving Data Streams, Mining Sequence Patterns in Transactional Databases: Sequential Pattern Mining Concepts and Primitives, Scalable Methods for Mining Sequential Patterns, Case Study. (4 hours)

Text/Reference:

- Jiawei Han and Micheline Kamber, Data Mining- Concepts and Techniques,(3e), Morgan Kaufmann Publishers, 2012.
- Jiawei Han and Micheline Kamber, Data Mining- Concepts and Techniques,(2e), Morgan Kaufmann Publishers, 2010.
- G. K. Gupta, Introduction to Data Mining with Case Studies, (3e), PHI Learning Pvt. Ltd., 2014.
- Mohammed J. Zaki, Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2017.
- Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, Introduction to Data Mining, (2e), Pearson Addison Wesley, 2020.
- Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, (3e), Elsevier Science, 2011.

MACHINE LEARNING LABORATORY

ICS 248 **0 - 0 - 6 - 2**

The experiments and mini project are based on following topics:

Understanding basics of machine learning programming using python, fundamental mathematical concepts required for machine learning. Experiments on preparation of data for machine learning algorithms, Naïve Bayes classifier, Bayesian Belief Networks, k-Nearest Neighbour classifier, Linear and Polynomial Regressions, Logistic Regression, Support Vector Machines, K-Means clustering, EM algorithm, Gaussian Mixture Models, Hierarchical Clustering, Decision Trees.

Text/Reference:

- M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018
- Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press. 2010.
- Peter Harrington, Machine Learning in Action, Manning Publications, 2012.
- Andreas C. Müller & Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media Inc., 2017.
- Tom M Mitchell, Machine Learning, McGraw Hill, 2017.

BIG DATA ANALYTICS LABORATORY

ICS 249 **0 - 0 - 6 - 2**

The experiments and mini project are based on following topics:

Hadoop Installation and HDFS Commands, Hadoop Map Reduce and Hive, Introduction to PySpark: Basic Commands, PySpark: RDD, Loading Data and Operations on RDD, Recommendation System, Prediction with Decision Trees, Anomaly detection with K-means Clustering, Analyzing graph data with GraphX, Estimating Risk Through Monte Carlo Simulationt.

Text/Reference:

- Tom White, Hadoop: The definitive guide (4e), O'Reilly, 2015.
- Vignesh Prajapathi, Big Data Analytics with R and Hadoop, Packt Publishing, 2013.
- Jeffery Aven, Data Analytics with Spark using Python, Pearson, 2018.
- Sandya Ryza, Uri Laserson, Sean Owen and Josh Wills, Advanced Analytics with Spark (2e), O'Reilly Media Inc, 2017.
- Holden Karau, Andy Konwinski, Patrick Wendell and Matei Zaharia, Learning Spark: Lightning-Fast Big Data Analysis (2e), O'Reilly Media Inc, 2020.