B.Tech CSE electives Syllabus

Hons. Elective I (fifth semester)

CS-3007	Decision making and Expert System	L-T-P-C:3-1-0

Course objective:

1. To learn a variety of reasoning, optimization, and decision-making techniques for developing expert systems.
2. To implement the basic algorithms in reasoning, optimization and learning, decision making and expert systems .

Course content: (consists of at least 4 units**)**

Unit 1 Introduction, Strategic decision making, Propositional and First order logic, Inference in first order logic, Unification, Forward Chaining, Backward Chaining, Resolution, Uncertainty, Probability fundamentals, The axioms of probability, Bayes rules, Representing knowledge in uncertain domain, The Semantics of Bayesian networks, Exact and uncertain inference in Bayesian networks, Other approaches to uncertain reasoning.

Unit 2: Probabilistic reasoning over time**,** Inference in temporal models, Hidden Markov models, Kalman filters, Dynamic Bayesian Networks, Basic utility theory, Utility function, Multi-attribute utility functions, Decision networks, The value of information, decision theoretic expert systems, Sequential decision problems, Value iteration, Policy iteration, Decision with multiple agents.

Unit 3: Learning from observations, Inductive learning, Learning decision trees, Ensemble learning, Computational learning theory, Knowledge in learning, Explanation based learning, Learning using relevance information. Inductive logic programming.

Unit 4: Expert Systems: Introduction, Architecture, Utilization and functionality of expert systems, A toy and Prolog as inference engines, Knowledge bases, Coherence of Knowledge bases, Modeling of uncertain reasoning, Reductions of set of rules, Representation, decomposition, hierarchy and the semiotic analysis of knowledge, Multi-dimensional and augmented transition networks, Object representations and object languages.

Unit 5: Syntactic and semantic analysis of discursive Grammar, The semiotic Square, Applications of semiotic theory of artificial intelligence in Expert systems and temporal reasoning.

Course outcome:

1. Able to model decision making problems using major modeling formalisms of artificial intelligence.
2. Able to evaluate the computational performance of optimization and learning algorithms.
3. Able to design and implement expert systems in several real world problem domains.

Text Book:

1. Stuart Russel and Peter Norvig; Artificial Intelligence: A modern approach, 2nd ed.,Pearson Education Inc.,2003.
2. Jean-Louis Ermine; Expert Systems, Theory and Practice, Prentice-Hall of India, New Delhi, 2015

Reference Book:

1. Robert I. Levine, Diane E. Drangand Berry Edelson; A Comprehensive Guide to AI and Expert Systems, McGraw

	International Editions, 1988. 2. Judea Pearl; Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann Publishers Inc., 1988.

CS-3009	**Advanced Operating Systems**	**L-T-P-C:3-1-0**
Course objective:	1. To learn the distributed computing techniques, 2. To learn techniques of process management, file systems, shared memory and security in distributed operating systems. 3. To learn design principles and the implementation of distributed operating system	

Course content: (consists of at least 4 units**)**

Unit 1 Introduction, evolution, types and various system models, processes communication, RPC, RMI, computing environment and design issues of distributed systems, Remote procedure calls, RPC transparency and messages, Communication Protocols, Exception handling, Server management and parameter passing semantics, Network types, LAN, WAN, ATM technologies, Communication protocols, Internet working, Client and Server threads.

Unit 2: Message Passing, IPC, Synchronization, Buffering, Encoding and Decoding, Process addressing, Election, migration and resilience of processes, Threads, Failure handling, Group communication, Case studies, 4.3 BSD, UNIX IPC mechanism .

Unit 3: Synchronization, Types of clock and their synchronization, mutual exclusion of distributed OS, Consensus and related problems of Various types of consistency, Consistency protocols, Fault tolerances.

Unit 4: Distributed shared memory, Design and implemented issues, Consistency models, Replacement strategies, Thrashing, File systems models, Design principles, File accessing, sharing, caching, replication and atomic transactions, Terminology and concepts of naming, System and Human oriented names, Object locating mechanisms, Name Cache, Naming and security, DCE directive service.

Unit 5: Protection and security in distributed systems, Various types of security techniques, Cryptography, Authentication, Access control, Digital signature, Design principles, DCE security service, Examples of distributed systems.

Course outcome:	• Able to attain knowledge of various architectures used to design distributed systems such as client-server and peer-to-peer. • Able to build distributed systems using various inter-process communication techniques, such as remote method invocation, remote events, distributed mutual exclusion, distributed monitors and tuple spaces. • Able to attain the knowledge of different distributed algorithms such as logical clocks and leader election. • Able to design and analyze distributed operating systems that fulfills requirements with regards to key distributed computing.

Text Book:	1. Pradeep K. Sinha; Distributed Operating Systems: Concepts and Design, PHI Learning Private Limited, New Delhi, 2011. 2. Paul J. Fortier; Design of Distributed Operating Systems, Concepts and Technology, McGraw-Hill International Editions, 1996.
Reference Book:	1. George Coulouris, Jean Dollimore and Tim Kindberg; Distributed Systems: Concepts and Design, 3rd Ed., Pearson Education Limited,2001. 2. Mukesh Singhal and Niranjan G.Shivaratri; Advanced Concepts in operating Systems, Distributed, database and Multiprocessor Operating Systems, Tata McGraw-Hill Edition, 1994.

CS-3011	**Queueing Theory and Data Networks**	**L-T-P-C:3-1-0**

Course objective:	1. To understand the basic concepts of probability of one and two dimensional random variables, some standard distributions and random processes used in IT. 2. To understand the concept and significance and applications of queueing models and their applications to engineering problems of real life phenomenon. 3. To learn about the basic concepts of how digital data is transferred across various types of data communication links.

Course content: (consists of at least 4 units**)**

Unit 1: Probability theory, Axioms of probability, Conditional probability, Baye's theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

Unit 2: Joint distributions, Marginal and conditional distributions, Covariance, Correlation and linear regression, Transformation of random variables, Central limit theorem for independent and identically distributed random variables, Markov chain theory.

Unit 3: Queueing model fundamentals, Little's law, M/M/1 and its variants M/G/1, G/M/1 and priority queues. Time-reversibility and multidimensional queueing models, Queueing networks, Jackson's theorem and product form.

Unit 4: Introduction to communications networks, Bit rate, Baud rate, Sampling, Nyquist bit rate, Shannon Theorem, Bandwidth, Throughput. PCM, Delta Modulation, Serial & parallel transmission, Amplitude modulation, frequency modulation and phase modulation, ASK, BPSK, QPSK, FSK, QAM, Multiple access control and ARQ.

Unit 5: Modems, Multiplexing, Spread spectrum modulation, Pseudo noise sequences, DS & FH spread spectrum, Synchronous and asynchronous transmission, Line coding scheme, Error detection and correction.

Course outcome:	1. Understand the various Queueing models and random processes

	and signals. 2. Learn the concepts of digital data transfer across various types of data communication links. 3. Understand and compute quantitative metric performance for queueing systems.
Text Book:	1. Mischal Schwartz; Telecommunications Networks: Protocols Modeling and Analysis by, Addison-Wesley, 1987. 2. Arnold Q. Allen; Probability, Statistics and Queueing theory with Computer Science Applications, 2nd.Ed., Academic Press, 1990.
Reference Book:	1. L. Kleinrock; Queueing Systems, by John Wiley & Sons, 1975. 2. D. Bertsekas and R. Gallager; Data Networks, 2nd Edition, Prentice-Hall, 1992.

CS-3013	**Game Theory**	**L-T-P-C:3-0-0-3**

Course content:

Unit I: Non-cooperative Game Theory: Games in Normal Form - Preferences and utility, examples of normal-form, Analysing games: Pareto optimality, Nash equilibrium, Maxmin and minmax strategies, dominated strategies, Rationalizability, Correlated equilibrium

Unit II: Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two- player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing Nash equilibrium, Lemke–Howson algorithm, Searching the space of supports, Computing Nash equilibria of n-player, general-sum games, Computing maxmin and minmax strategies for two-player, general-sum games, Computing correlated equilibria

Unit III: Games with the Extensive Form: Perfect-information extensive-form games, Subgame-perfect equilibrium, Computing equilibria, Imperfect-information extensive-form games, Sequential equilibrium, Other Representations: Repeated games: Finitely repeated games, Infinitely repeated games, automata, Stochastic games Bayesian games: Computing equilibria

Unit IV: Coalitional Game Theory: Transferable Utility, Analysing Coalitional Games, The Shapley Value, The Core, Mechanism Design: Strategic voting, unrestricted preferences, Implementation, quasi linear setting, Efficient mechanisms, Computational applications of mechanism design, Task scheduling, Bandwidth allocation in computer networks

Unit V: Auctions: Single-good auctions, Canonical auction families, Bayesian mechanisms, Multiunit auctions, Combinatorial auctions.

Course outcome:	• Analyse games based on complete and incomplete information about the players • Analyse games where players cooperate • Compute Nash equilibrium • Apply game theory to model network traffic • Analyse auctions using game theory
Text Book:	1. Nisan, N., T. Roughgarden, E. Tardos, and V. Vazirani (Eds.). Algorithmic Game Theory. Cambridge University Press, 2007. 2. Shoham, Y. and Leyton–Brown, K. Multiagent Systems: Algorithmic, Game Theoretic, and Logical Foundations. Cambridge

	University Press, 2008.
Reference Book:	Osborne, M. J., and Rubinstein, A. A Course in Game Theory. Cambridge, MA: MIT Press, 1994.

Open Elective I (in sixth semester) – open to both CSE & ECE

OE-3002	Embedded Systems	L-T-P-C:3-0-0-3

Course objective:

- Understand architecture and advanced features of embedded processors.
- Understand ARM processor registers, instruction pipeline, interrupts and architecture.
- Understand building blocks of Internet of Things and characteristics.

Course Content:

Unit-I

Introduction to Embedded Systems: Definition of embedded system, classification, embedded systems v/s general computing, details of various embedded components, sensors & actuators, major application area, purpose if embedded system, characteristics and quality attributes of embedded systems

Unit-II

Arduino: The Arduino Platform, Block diagram, Architecture, Pin functions, overview of main features such as I/O Ports, timers, interrupts serial port, PWM and Arduino programming.

Unit-III

ARM: ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families. Instruction Sets: Data processing instructions, addressing modes, branch, load, store instructions, PSR instructions, and conditional instructions, ARM programming and case studies.

Unit-IV

Embedded Firmware Design: Embedded firmware design approaches and development languages.

Operating System for Embedded System: Types of operating system, tasks, process and threads, multiprocessing and multitasking, task scheduling, task synchronization, how to choose an Operating system.

Unit-V

IoT: Internet of Things basics and vision, IoT Platform overview, IoT architecture and applications, Security aspects in IoT, IoT Application protocols, case study & advanced IoT applications.

Course outcome:

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

- Understand architecture and instruction set for advanced embedded processors and controllers.
- Work with suitable embedded processors for a specific real world application.
- Learn application of IoT in Industrial and Commercial Automation along with Real World Design Constraints.

Text Book:

1. K. V. Shibu, “Introduction to embedded system”, McGraw Hill.
2. R. S. Kaler, “Microprocessors and Microcontrollers”, Wiley, Third Edition.
3. A. N. Sloss, D. Symes, and C. Wright, "ARM system developer's guide: Designing and optimizing system software", Elsevier, 2008
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hand Approach)”, 1st Edition, VPT, 20142.

Reference Book:

1. Daniel Tabak, “Advanced Microprocessors”, McGraw Hill. Inc., 1995.
2. SteaveFurber, “ARM system-on-chip architecture”, Addison Wesley, 2000.
3. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013.

OE-3004	Sensor and Transducer	L-T-P-C:3-0-0-3

Course objective:

- To understand the fundamental concept of sensor and transducer.
- To discuss about units, standards, error analysis and characteristics of measurement systems.
- To describe the principle of operation, construction and characteristics of resistance, inductance and capacitance & other transducers and its applications.

Course content:

Unit-I

Introduction to Sensor- Based Measurement Systems: General Concepts and Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials For Sensors, Microsensor Technology.

Unit-II

Resistive, Reactance Variation, Electromagnetic Sensors: Potentiometers, Strain Gages, Resistive Temperature Detectors (RTDs), Thermistors, Magneto resistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas Sensors, Liquid Conductivity Sensors, Signal Conditioning For Resistive Sensors: Resistance Measurement, Voltage Dividers, Dynamic Measurements, Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors.

Unit-III

Flow, Pressure and Level Transducers: Flow Transducers Like Differential Pressure, Variable Area, Positive Displacement, Electromagnetic, Anemometer, Ultrasonic Flow Meter, Turbine Flow Meter, Vortex Flow Meter, Electromagnetic Flow Meter, Coriolis Effect Flow Meter, Pressure Transducers Like Mercury Pressure Sensor, Bellows, Membranes and Thin Plates, Piezoresistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Sensors, Vacuum Sensors, Level Transducers Like Displacer, Float, Pressure Gages, Balance Method, Time-of-Flight Measurements, Level Measurements By Detecting Physical Properties.

Unit-IV

Self-Generating Temperature Sensors: Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Pyroelectric Sensors, Electrochemical Sensors, Acoustic Temperature Sensors, Nuclear Thermometer,

Magnetic Thermometer, Semiconductor Types, Thermal Radiation, Quartz Crystal, NQR, Spectroscopic Noise Thermometry, Heat Flux Sensors.

Unit-V

Digital and Semiconductor Sensors: Position Encoders, Resonant Sensors, SAW Sensors, Sensors Based on Semiconductor Junctions, Sensors Based on MOSFET Transistors, Charge-Coupled and CMOS Image Sensors, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors.

Unit-VI

Sensors for Robotics: Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors

Course outcome:

After completion of the course student will be able to:

- Idea behind working of measurement systems and different types of sensors and transducers.
- Sensor to measure various physical parameters used in Industry and normal measurement applications.
- Working principle of resistive, inductive and capacitive transducers and their applications.
- Understanding of thermocouples, piezoelectric and pyro-electric transducers and their applications.
- Understanding of acoustic, optical sensors and other sensors and their applications.
- Understanding of digital and proximity sensors and their applications.

Text Book:

1. Patranabis D., "Sensors and Transducers", Prentice-Hall India, 2nd Ed., 2004.
2. Ramon Pallas & John G. Webster, "Sensors and Signal Conditioning", John Wiley & Sons, 2nd Ed., 2001.
3. Shawhney A. K., "Electrical and Electronics Measurements and Instrumentation", DhanpatRai& Sons, 1994.

Reference Book:

1. Webster John G., "Instrumentation and Sensors Handbook", CRC Press, 1st Ed., 1999.
2. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004.

EC-3006	Information and Coding Theory	L-T-P-C:3-0-0-3

Unit-I

Introduction: Introduction to information theory & error control coding, Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Channel Capacity.

Unit-II

Source Coding: Shannon's Source Coding Theorem, Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Rate Distortion Theory.

Unit-III

Channel Capacity & Coding: Channel Coding Theorem, Markov Sources, Discrete Channel with discrete Noise, BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO system, Bandwidth-S/N Trade-off.

Unit-IV

Block Codes: Galios Fields, Hamming Weight and Hamming Distance, Linear Block Codes, Encoding and decoding of Linear Block-codes, Parity Check Matrix, and Bounds for block codes, Hamming

Codes, Syndrome Decoding.

Unit-V

Cyclic Codes: Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation of cyclic codes, Burst error correction, BCH codes.

Unit-VI

Convolutional Codes: Introduction to Convolutional Codes, Polynomial description of Convolutional Codes, Generating function, Matrix description of Convolutional Codes, Viterbi Decoding of Convolutional code, Introduction to Turbo Code.

Unit-VII

Coding for Secure Communications: Introduction to Cryptography, Overview of Encryption Techniques, Secret-Key Cryptography, Data Encryption, Standard (DES), Public-Key Cryptography, RSA algorithm, Digital signature, One- way Hashing.

Text Books:

1. "Information Theory, Coding & Cryptography", by Ranjan Bose, TMH, Second Edition.
2. "Communication Systems", by S. Haykin, 4th Edition, Wiley-Publication.

Reference Books:

1. "Elements of Information Theory" by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
2. "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, Wiley India Edition.
3. "Cryptography and Network Security", Fourth Edition, by William stallings.

EC-3008	Wireless Communication	L-T-P-C:3-0-0-3

Course objective:

- Know the characteristic of wireless channel
- Learn the various cellular architectures
- Understand the concepts behind various digital signaling schemes for fading channels
- Be familiar the various multipath mitigation techniques
- Understand the various multiple antenna systems

UNIT I

WIRELESS CHANNELS: Large scale path loss – Path loss models: Free Space and Two-Ray models - Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

UNIT II

CELLULAR ARCHITECTURE: Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.

UNIT III

DIGITAL SIGNALING FOR FADING CHANNELS: Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV

MULTIPATH MITIGATION TECHNIQUES: Equalization – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.

UNIT V

MULTIPLE ANTENNA TECHNIQUES: MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming – transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels

Text Books:

1. Rappaport, T. S., "Wireless communications", Second Edition, Pearson Education, 2010.
2. Andreas .F. Molisch, "Wireless Communications", John Wiley – India, 2006

Reference Books:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.
3. Van Nee, R. and Ramji Prasad, "OFDM for wireless multimedia communications", Artech House, 2000.

EC-3010	Computational Electromagnetics	L-T-P-C:3-0-0-3

Course objective:

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UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

Text Books:
Reference Books:

OE-3012	Quantum Mechanics	L-T-P-C:3-0-0-3

Module I
Introduction: Basic of quantum mechanics, Postulates of Quantum Mechanics-probability and probability current density, conservation of probability, equation of continuity, Schrödinger equation

Module II
Simple potential problems: infinite potential well, step and barrier potentials, finite potential well and bound states; Linear harmonic oscillator, operator algebra of harmonic oscillator, coherent states and their properties

Module III
Three dimensional problems: spherical harmonics, free particle in a spherical cavity, central potential, Three dimensional harmonic oscillator, degeneracy, Hydrogen atom

Module IV
Angular momentum: Commutation relations, spin angular momentum, Pauli matrices, raising and lowering operators, L-S coupling, Total angular momentum, addition of angular momentum, Clebsch-Gordon coefficients; The spin-orbit coupling and its consequences, charged particle in a uniform magnetic field

Text Books:

1. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).
2. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd Ed., Pearson Education (2005).

Reference Books:

1. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
2. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).

OE-3014	Advanced Algorithms	L-T-P-C:3-0-0-3

Course objective:

- Understand advanced concepts of computer algorithms and learn modern techniques of problem solving
- Learn complexity classes and limit of computation
- Learn role of randomness and approximation to solve intractable problems

Course content:

Unit 1: Preliminaries: Problem vs. Solutions. Algorithms vs. Programs. Properties of Algorithm. Complexity Measures. Model of Computation – RAM model (Architecture, instruction set, usage) Turing Machine (concept, usage, DTM and NDTM as lanuage acceptors, Universal TM). Cellular Automata as a natural model of computation. Examples.

Unit 2: Revisit of Asymptotic Notation and Basic Algorithm techniques: Growth of function over input size – Big-Oh, Big-Omega, Big-Theta Notation and their relationship. Master's theorem. Recursion tree. Searching techniques – Linear search vs Binary search. Different sorting techniques – sort by insertion, sort by exchange, sort by selection, sort by merging, special purpose sorting. Lower Bound Theory. Hashing. Divide and conquer vs Greedy Strategy – when to use what. Examples.

Unit 3: Limit of Computation: Classes of languages. Entscheidungs Problem and Decidability. Computability theory: enumerability/countability, Recursively Enumerable vs. Recursive languages, partial and total function, Effectively Computable, Efficient algorithm, Church-Turing Hypothesis, padding lemma, computability theorems. Russell's Paradox. Halting Problem. Inconsistency. Reducibility. Classes of Problems: P, NP, NPC, NP hard problems. Turing Equivalence and Turing degree. Turing Test. Examples.

Unit 4: Randomized Algorithms: Use of randomness in computing. Average case analysis – Case study: Quick sort.

Unit 5: Approximation Algorithms: Optimization Problems – Efficiently solvable and Intractable optimization problem, Pseudo-polynomial time algorithm, Weakly and Strongly NP-Completeness. Approximation ratio, Absolute approximation, Relative Approximation, Approximation scheme – Polynomial time approximation scheme, fully polynomial time approximation scheme (FPTAS). Example – Solution of Travelling Salesperson Problem using Triangular Inequality, FPTAS solution for Knapsack problem

Text Book:

1. Introduction to Algorithms – Cormen, Leiserson, Rivest and Stein
2. Fundamentals of Computer Algorithms – Horowitz and Sahni
3. The Design of Approximation Algorithms – David P. Williamson and David B. Shmoys, First Edition, 2011.

Reference Books:

1. The Design and Analysis of Computer Algorithms – Aho, Hopcroft and Ullman
2. The Art of Computer Programming (Vol 1 & 3) – Donald E Knuth
3. Approximation Algorithms – Vijay V. Vazirani, First Edition.
4. A New Kind of Science – Stephen Wolfram

OE-3016	Advanced Data Structure	L-T-P-C:3-0-0-3

Course content:

Unit 1. Elementary Structures: Stack, Queue, Double-Ended Queue, Dynamical Allocation of Nodes, Shadow Copies of Array-Based Structures.

Unit 2. Search Trees: Two Models of Search Trees, General Properties and Transformations, Height of a Search Tree, Basic Find, Insert, and Delete, Returning from Leaf to Root, Dealing with Nonunique Keys, Queries for the Keys in an Interval, Building Optimal Search Trees, Converting Trees into Lists, Removing a Tree.

Unit 3. Balanced Trees: AVL Trees- Maximum Height of an AVL Tree, Insertions and Deletions, Splay trees, 2-3 trees, 2-3-4 trees, Red-black trees Insertion, Deletion.

Unit 4. Text Processing: Pattern matching algorithms-Brute force, the Boyer Moore algorithm, the Knuth-Morris-Pratt algorithm. Tries: Definition and concepts of digital search tree, Binary trie, Patricia, Multi-way trie.

Unit 5. Dictionaries –Sets, Hash tables representation, hash functions (Division Method, Multiplication Method, Universal Hashing), collision resolution-separate chaining, open addressing-linear probing, quadratic probing, double hashing, rehashing. Skip lists and analysis of Skip List.

Course outcome:

- Implement a fully encapsulated perfect and non perfect hashed structure accessed in the key field mode.
- Implementation of hash tables, including collision avoidance and resolution schemes.
- Analyze how to balance a binary search tree using rotation methods and color changing methods
- Solve problems using graph algorithms, including single-source and all-pairs shortest paths, and minimum spanning tree algorithms.
- Relates all binary heap trees to form a large binomial queue for large data structures creation.
- Generates new searching algorithms for websites to match the specified string, numeric or both in an application.
- Reconstructs such applications that take the advantage of a trie's ability to quickly search for, insert, and delete entries into the dictionary.

Text Book:

1. Advanced Data Structures, PETER BRASS, Cambridge University Press.

Reference Book:

1. Data structures, Algorithms and Applications in C++, S.Sahni, University Press (India) Pvt.Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.

OE-3018	Programming in JAVA	L-T-P-C:3-0-0-3

Course content:

Unit 1. Introduction: OOP Principles, Encapsulation, Inheritance and Polymorphism, data types, variables, declaring variables, scope and life time of variables, arrays, operators, control statements, type conversion and casting.

Unit 2. Classes and Objects : Concepts of classes and objects, class fundamentals Declaring

objects, introducing methods, constructors, usage of static with data and methods, access control, this key word, garbage collection, overloading methods and constructors, parameter passing – call by value, recursion.

Unit 3. Inheritance: Basic concepts, member access rules, usage of super key word, types of inheritance, method overriding, abstract classes, dynamic method dispatch, final keyword. Packages and Interfaces : Defining, Creating and Accessing a Package, Understanding CLASSPATH,importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces.

Unit 4. Exception Handling and Multithreading : Concepts of Exception handling, types of exceptions, usage of try, catch, throw, throws and finally keywords, Built-in exceptions, creating own exception sub classes, Concepts of Multithreading, differences between process and thread, thread life cycle, creating multiple threads using Thread class, Runnable interface, Synchronization, thread priorities, inter thread communication, deadlocks.

Unit 5. Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes. Applets and swings: Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets, graphics class. Swings – JApplet, JFrame and JComponent, Icons and Labels, text fields, buttons –The JButton class, Check boxes, Radio buttons, Combo boxes, Tabbed Panes, Scroll Panes, Trees, and Tables.

Course outcome:

Upon completion of this course, students should be able to:

- Understand the concept of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem
- To demonstrate the ability to understand and use Exception handling and file handling mechanism
- Arrange the concrete and abstract classes in an appropriate hierarchy.
- Develop efficient Java applets and applications using OOP concept

Text Book:

1. The Complete Reference Java J2SE 5th Edition, Herbert Schildt, TMH Publishing Company Ltd, New Delhi.
2. "Learn Object Oriented Programming Using Java: An UML Treatment using Live Examples from Science and Engineering," Dr. N.B. Venkateswarlu, Dr. E.V. Prasad, S Chand, New Delhi.

Reference Book:

1. Java How to Program, Sixth Edition, H.M.Dietel and P.J.Dietel, Pearson Education/PHI

OE-3020	Parallel and Distributed Systems	L-T-P-C:3-0-0-3

Course content:

Unit 1. Introduction of Parallel computing: Parallel Computing, Parallel Architecture, Architecture Classification Scheme, Performance of Parallel Computers, Performance metric for Processors, Parallel Programming Models, Parallel Algorithm, Pipeline Processing: Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline stage Design, Hazards, Dynamic Instruction Scheduling.

Unit 2. Synchronous Parallel Processing: Introduction, SIMD Architecture and Programming Principles, SIMD Parallel Algorithm, Data Mapping and Memory in array processors, Case studies of SIMD Parallel Processor.

Unit 3. Introduction to Distributed System: Definition, Issues, Goals, Types of Distributed system models,, Hardware concepts, Software concepts, models of middleware, services offered by middleware, client-server model.

Unit 4. Communication: Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication, Resource and Process management: Desirable features of global scheduling algorithm, Task assignment approach, Load balancing approach, Load Sharing approach, Introduction to Process management, Process migration, Threads, Virtualization, clients, servers, code migration.

Unit 5. Synchronization: Clock synchronization, Logical Clocks, Election algorithm, Mutual Exclusion, Distributed mutual exclusion, classification of mutual exclusion algorithm, requirements of mutual exclusion algorithms, Performance measures, Non-token based algorithm: Lamport Algorithm, Token based algorithm: Suzuki-Kasami's Broadcast algorithm, Comparative Performance analysis.

Unit 6. Consistency and Replication: Introduction, Data centric and client centric consistency model, Replica management, Distributed file systems, file accessing model, file replication, Network file system, Andrew file system, Hadoop distributed file system and Mad Reduce.

Course outcome:

- Design and analyse the parallel algorithms for real world problems and implement them on available parallel computer systems
- Optimize the performance of a parallel program to suit a particular hardware and software environment
- Understand models of distributed computing
- Analyse algorithms for coordination, communication, security and synchronization in distributed systems
- Design and Implement distributed file systems

Text Book:

1. Kulkarni A, Giri N P, Joshi N, Jadhav B, Parallel and Distributed Systems, Wiley

Reference Book:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar : Introduction to Parallel Computing, Pearson
2. Andrew S. Tanenbaum, Maarten Van Steen, Distributed Systems -Principles and Paradigms, PHI

OE-3022	OBJECT ORIENTED SYSTEM DESIGN	L-T-P-C:3-0-0-3

Course content:

Unit 1: Fundamental concepts of object oriented programming: Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers).

Unit 2: Object design implementation in a programming language, e.g., C++ or Java. Object oriented analysis, modeling and design: UML may be introduced. Use cases, use case driven analysis.

Unit 3: Structural modeling classes, relationships, interfaces, class diagrams, and object diagrams, in UML. Behavioral/Functional modeling use case diagrams, sequence diagrams, in UML.

Unit 4: Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns. Distributed object model: CORBA and COM / DCOM

Unit 5: Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases.

Course outcome:	This course will cover object-oriented approach to modeling, problem solving, requirement analysis, system design, system implementation, database design, system engineering and software engineering.
Text Book:	1. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall. 2. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
Reference Book:	Kim Bruce, Foundations of Object Oriented Languages, Prentice-Hall.

Hons. Elective II (sixth semester)

CS-3008	Multimedia Systems	L-T-P-C:3-0-0-3

Course content:

Unit I: Introduction to multimedia systems: Broad characteristics, requirements, and what makes them different, Operating system requirements, disc layout and scheduling, Multimedia databases

Unit II: Media characteristics & Compression techniques: Images, Audio, Video, 3D Models and 3D Motions, Metadata generation: Image and Video Segmentation, Shape based 3D retrieval.

Unit III: Indexing Structures: R-tree family, Interval tree family, special structure for 3D motion data indexing

Unit IV: Streaming Multimedia Data: Video streaming, 3D models streaming, 3D animation streaming.

Unit V: Watermarking techniques and Security: General strategies , emphasis on 3D watermarking, Security Architectures, Multimedia server architecture

Course outcome:	• Understand big data challenges in different domains including social media, transportation, finance and medicine • Analyse scalability and performance of relational model, SQL and emergent systems. • Comprehend machine learning and algorithms for data analytics. • Understand the capability of No-SQL systems • Build secure big data systems

	• Analyse Map-Reduce programming model for better optimization
Text Book:	1. Multimedia Systems Design, Prabhat K. Andleigh, Kiran Thakrar, Pearson India Publishers
Reference Book:	1. Multimedia Databases Management Systems, B. Prabhakaran, Kluwer Academic Publishers 2. Multimedia Systems, Ralf Steinmetz and Klara Nahrstedt, X.Media Publishing

CS-3010	**Web System and Technology**	**L-T-P-C:3-0-0-3**

COURSE OBJECTIVES:

The main objectives of this course are

- Understanding the concept of web technologies.
- Creating web pages by using HTML
- Applying JavaScript validations
- Understanding the use of XML in Advanced Web Technologies
- Understanding the importance of Java Beans in Architectures like MVC
- Creating interactive web pages by Using Servlets.
- Understanding the advantages of JSP over Servlets and MVC Architecture
- Understanding Database Connectivity

Course content:

Unit 1: HTML Introduction, Common tags - Lists, Tables, images, forms, Frames; Cascading Style sheets; Introduction to Java Script, Events & Objects in Java Script, Dynamic HTML with Java Script.

Unit 2: XML: Document Type Definition, XML Schemas, Document Object Model, Presenting XML, Using XML Processors: DOM and SAX.

Unit 3: Installing the Java Software Development Kit, Tomcat Server & Testing Tomcat Introduction to Servlets: Lifecycle of a Servlet, The Servlets API, The javax.servlet Package, Reading Servlets parameters, Reading Initialization parameters, The javax.servlet.http package, Handling HttpRequest & Responses, Using Cookies & Session Tracking, Security Issues.

Introduction to JSP: The Problem with Servlets, The Anatomy of a JSP Page, JSP Processing. JSP Application Design with MVC.

Unit 4: JSP Application Development: Generating Dynamic Content, Using Scripting Elements, Implicit JSP Objects, Conditional Processing – Displaying Values Using an Expression to Set an Attribute, Declaring Variables and Methods Error Handling and Debugging Sharing Data Between JSP pages, Requests, and Users Passing Control and Date between Pages.

Unit 5: Database Access: Database Programming using JDBC, Studying Javax.sql package, accessing a Database from a JSP Page, Application Specific Database Actions.

Course outcome:	The above exercise shall make the students competent in the following ways and will be able to learn following parameters at the end of the course. • Able to build Web pages using HTML • Able to Validate the forms using JavaScript • Able to applying styles to web pages • Able to retrieve data from XML Files Using Parsers • Able to develop the web applications by using MVC

	Architecture • Students should be able to apply their computer science skills to the create a website with some understanding of the legal, security, commercial, marketing and other issues involved. • Recognize and understand ways of using different web technologies • Able to create Database Applications.
Text Book:	1. Web Programming, building internet applications, Chris Bates 2nd edition, WILEY Dreamtech 2. The complete Reference Java 2 Fifth Edition by Patrick Naughton and Herbert Schildt. TMH
Reference Book:	1. Programming world wide web-Sebesta, Pearson

CS-3012	**Evolutionary Computing**	**L-T-P-C:3-0-0-3**
Course objective:	• Gain understanding of various evolutionary computation techniques • Identify algorithms suitable for solving certain evolutionary-computation problems • Apply evolutionary computation techniques to optimization, learning, and design • Implement at least one algorithm from each of the following groups: generic algorithms, representations, selections, and search operators • Compare and contrast algorithms in each group mentioned above	
Course content: **Unit 1: Introduction to Evolutionary Computation:** Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, etc. A simple evolutionary algorithm **Unit 2: Search Operators:** Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc. **Unit 3: Selection Schemes:** Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search **Unit 4: Evolutionary Combinatorial Optimization:** Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms **Unit 5: Genetic Programming:** Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc. Examples.		
Course outcome:	• Formulate a problem as an evolutionary computation search/optimization by specifying representations, selection and	

	variation operators. • Write a program or use a package to implement an evolutionary algorithm. • Conduct evolutionary optimization experiments and properly report and discuss the results.
Text Book:	1. **An Introduction to Genetic Algorithms**, Melanie Mitchell, MIT Press, 1996. 2. **Genetic Programming**, John Koza, MIT Press, 1992. 3. **Evolutionary Computation**, The Fossil Record, David Fogel, IEEE Press, 1998.
Reference Books:	5. **Evolutionary Computation 1: Basic Algorithms and Operators** – Bäck, T, Institute of Physics Publishing, Bristol**.** 6. **Evolutionary Computation : Toward a New Philosophy of Machine Intelligence –** Fogel, D.B.**,** 2nd ed. Wiley-IEEE Press**.** 7. **Genetic Algorithms in Search, Optimization, and Machine Learning –** David Goldberg. Addison-Wesley, 1989. 8. **Introduction to Evolutionary Computing –** Eiben and Smith. Springer-Verlag, Corrected 2nd printing, 2007

CS-3014	**Introduction to Cognitive Science**	**L-T-P-C:3-0-0-3**
Course objective:	The main goal of this course is to introduce basic concepts of cognitive science, the basic methods of cognitive science and the main researches in the field of cognitive science.	

Course content:

Unit 1: Introduction to Cognitive Science: Introduction to the study of cognitive sciences. A brief history of cognitive science. Methodological concerns in philosophy, artificial intelligence and psychology.

Unit 2: Psychology, Nervous system and brain: Structure and constituents of the brain; Brief history of neuroscience; Mathematical models; Looking at brain signals. Brain and sensory motor information: Processing of sensory information in the brain. Representation of sensory information: Neural Network Models; Processing of sensory information in the brain; motor and sensory areas; Brain Imaging, fMRI, MEG, PET, EEG.

From Sensation to Cognition; Roots of Cognitive Science: Multisensory integration in cortex; information fusion; from sensation to cognition, cybernetics; From physics to meaning; Analog vs. Digital: Code duality.

Unit 3: Language

What is language?; Linguistic knowledge: Syntax, semantics, (and pragmatics); Generative linguistics;

Brain and language; Language disorders; Lateralization; The great past tense debate. Embodiment : Cognitivist and emergent standpoints ; A robotic perspective.

Unit 4: Affordances in biological and artificial systems: Affordances, direct perception, Ecological Psychology, affordance learning in robotics. Cognitive Development: Development, child and robotic development.

Attention: Attention and related concepts; Human visual attention; Computational models of attention; Applications of computational models of attention. **Unit 5:** Learning: Categories and concepts; Concept learning; Logic; Machine learning. Memory: Constructing memories; Explicit vs. implicit memory; Information processing (three-boxes) model of memory; Sensory memory; Short term memory; Long term memory. Reasoning: Rationality; Bounded rationality; Prospect theory; Heuristics and biases; Reasoning in computers. Social Cognition: Key points in social cognition; Context and social judgment; Schemas; Social signals	
Course outcome:	At the end of the course student will ● Know the subject and main concepts of cognitive science, its fields, connections with other disciplines, and how it bridges knowledge from multiple perspectives. ● Know basic contribution of disciplines such as philosophy, psychology, neuroscience and artificial intelligence to cognitive science. ● Know the basic methods and researches in the field of cognitive science ● Know the essence of the main methodological problems of cognitive science ● Be able to choose an adequate method of cognitive science, in accordance with the research task. ● Be able to critically and orally present on content from various approaches and interpret with respect to cognitive science.
Text Book:	1. Gardner, The Mind's New Science, chapters 2,3,4. Gardner, Howard E. The mind's new science: A history of the cognitive revolution. Basic books, 2008. 2. Chapter 1 and section 2.3, Bermúdez, José Luis. Cognitive science: An introduction to the science of the mind. Cambridge University Press, 2014. 3. Lecture notes for McCullogh-Pitts and Rosenblatt Neural Networks: http://ecee.colorado.edu/~ecen4831/lectures/NNet2.html 4. Stein, B. E., Meredith, M. A., Huneycutt, W. S., & McDade, L. (1989). Behavioral indices of multisensory integration: orientation to visual cues is affected by auditory stimuli. Journal of Cognitive Neuroscience, 1(1), 12-24. 5. Fromkin, Rodman, and Hyams. An Introduction to Language, Boston, MA: Thomson Wadsworth, 9th edition, 2011, chapters 1-2. 6. Calvo & Gomila, "Handbook of cognitive science", 2008 7. Introduction to Psychology, Chapter 3, pg. 68-86.

	8. Vecera & Luck, Attention, Encyclopedia of the Human Brain, Pages 269-284 9. Atkinson&Hilgard's Introduction to Psychology, Chapter 8, Memory 10. Atkinson et al., Intro. To Psychology, chapter 9 11. Kasslin, chap 11: Social and Cultural Influences
Reference Book:	

EC-3006	**Digital Signal Processing**	**L-T-P-C:3-0-0-3**

Course objective:

- To provide detailed principles and algorithms of digital signal processing.
- Able to have basic knowledge of digital signal processing.

Unit 1

Introduction: Overview of Discrete time signals and systems Z-Transform: Generalized complex exponentials as eigen signals of LTI systems, z-transform definition, region of convergence (RoC), properties of RoC, properties of the z-transform, inverse z-transform methods-pole-zero plots, time-domain responses of simple pole-zero plots, RoC implications of causality and stability.

Unit 2

Properties and applications of DFT, implementing linear time invariant systems using DFT, circular convolution, linear convolution using DFT; Fast Fourier Transform, FFT algorithms: Decimation in time, decimation in frequency; Goertzel algorithm; Application of transform in speech, audio, image and video coding, Karhunen-Loeve Transform, JPEG and MPEG coding standards

Unit 3

IIR and FIR filters, filter design specifications; Design of digital IIR filters: Impulse invariant, and bilinear transformation techniques for Butterworth and Chebyshev filters; Design of FIR filters: Windowing, frequency sampling filter design, optimum approximations of FIR filters.

Unit 4

Adaptive systems: Definitions, characteristics, applications, properties, and examples. Adaptive filtering, adaptive equalization, noise cancellation and beam forming.

Unit 5

Fundamentals of multirate systems, Decimation and interpolation, application of Multirate DSP in sampling rate conversion; Filter banks; Polyphase structures; Quadrature-mirror filter bank; Wavelet transform and its relation to multi-rate filter banks; applications to speech and

audio coding.

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

- Understand the discrete time systems and visualize the operation of filters.
- Able to analyze digital systems in time and frequency domain.

Text Book:

1. Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm and Applications".
2. Alan V. Oppenheim,"Discrite-time signal processing", pearson.

Reference Book:

1. S. K. Mitra, "Digital Signal Processing: A Computer Based Approach", TMH.
2. B. Widrow and S. D. Stearns, "Adaptive Signal Processing", Prentice Hall.

EC-3106	Digital Signal Processing lab	L-T-P-C:0-0-3-2

Different signals waveform, Discrete convolution (linear and circular), Z-Transform , Discrete Fourier transform and inverse discrete Fourier transform using FFT algorithm (DIT-FFT and DIF-FFT). Analog Butterworth filter and Chebyshev filter, time and frequency domain response (impulse response and step response) for a given FIR and IIR systems. Record a signal using Raspberry Pi and Perform signal processing on recorded sample of signal. Develop and test the Inverse Discrete Fourier Transform (IDFT), Finite Impulse Response (FIR) filters using Arduino.

Open Elective II/III/IV (in seventh semester) – open to both CSE & ECE

OE-4001	Satellite and Radar Communication	L-T-P-C:3-0-0-3

Course objective: To become familiar with satellite, launching and its services.

Course content:

Unit-I

Overview of Principles of communication, modulation and receiver, historical Developments, Elements of Satellite Communication, Orbital mechanics, look angle and orbit determination, launches and lauch vehicle, orbital effects, Introduction to geosynchronous and geo-stationary satellites.

Unit-II

Satellite sub-systems: Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Introduction to satellite link design, basic transmission theory, system noise temperature and G/T ratio, design of down link and uplink, design of satellite links for specified C/N, satellite data communication protocols.

Unit-III

Direct broadcast satellite television and radio, satellite navigation and the global positioning systems, GPS position location principle, GPS receivers and codes, Satellite Signal Acquisition, GPS navigation Message, GPS Signal Levels, Timing Accuracy, GPS Receiver Operation.

Unit-IV

Introduction to radar, radar block diagram and operation, radar frequencies, Applications of radar, The

Radar Equation: Detection of signals in noise , Receiver noise and the signal to noise ratio, Probabilities of detection and false alarm, Integration of Radar Pulses, Radar cross section of targets, Radar cross section fluctuations, Transmitter Power, Pulse Reception Frequency , Antenna Parameters, System Losses.

Unit-V

Tracking Radar: sequential lobbing, conical scan, mono-pulse Tracking, low angle tracking, tracking in range. MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Delay Line cancellers, Staggered Pulse Reception Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance.

Course outcome:

After studying this course, the students will be able to

- Understand the orbital and functional principles of satellite communication systems.
- Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link

Text Book:

1. T. Pratt, C. Bostian and J. Allnutt, "Satellite Communications," 2nd Edition, Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "Satellite Communication Systems Engineering," 2nd Edition., Pearson Education, 2012.

Reference Book:

1. G. Gordon and W. Morgan, "Principles of Communications Satellites,"
2. D. I. Dalgleish "An Introduction to Satellite Communications", IET Publisher.

OE-4003	Digital System Design with VHDL	L-T-P-C:3-0-0-3

Course objective:

- To prepare students to understand the use and application of Boolean algebra in the areas of digital circuit reduction, expansion, and factoring.
- To acquire the concept of the IEEE Standard in Hardware Description Language and be able to simulate & debug digital systems described in VHDL.
- To have knowledge to synthesize complex digital circuits at several level of abstractions.

Course content:

Unit 1:

VLSI Design Flow, Gajski-Y chart, Basic concepts of hardware description languages. Design flow for VHDL/Verilog based RTL/logic synthesis. Hierarchy, Concurrency, Logic, and Delay modeling, Structural, Data-flow and Behavioral styles of hardware description. Architecture of event driven simulators.

Unit 2:

Syntax and Semantics of Verilog/VHDL. Variable, signal types, arrays, attributes and tables. Data types, Operators, expressions and signal assignments. Entities, architecture specification and configurations. Component instantiation.

Unit 3:

Use of Procedures, Tasks and functions, Memory Modelling, Examples of design using Verilog/ VHDL.

Unit 4:
Concurrent and sequential constructs. Examples of design using Verilog. Sequential Circuit design, Finite State Machine Modeling.

Unit 5:
Synthesis of combinational and sequential circuits.

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

- understand basics of hardware description languages.
- implement various examples of digital IC designs using hardware description languages.
- account for the syntax and behavior of the VHDL language.
- use modern development tools to design complex digital circuits

Text Book:

1. S. Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall NJ, USA, 1996.
2. Z. Navabi, "VHDL: Analysis and Modeling of Digital Systems", McGraw Hill International Ed. 1998.

Reference Book:

1. Michael D. Ciletti "Advanced Digital Design with the Verilog HDL", Prentice Hall India, 2005.
2. J. Bhaskar, "VHDL Primer", Pearson Education Asia, 2001.
3. Peter Ashenden, "Digital Design using VHDL", Elsevier, 2007.

OE-4005	Advanced Semiconductor Devices	L-T-P-C:3-0-0-3

Course objective:

- To learn how to design advance semiconductor devices.
- To learn techniques and tools for semiconductor device measurement
- To understand the limitations and difficulties in modern semiconductor devices, including wiring constraints, high-speed, etc.

Unit-I

Introduction of Semiconductor Devices: Introduction, Ohmic contact, Rectifying contact, Current transport across a metal-semiconductor boundary, Metal-Insulator-Semiconductor(MIS) System, Metal-Semiconductor-Field-Effect-Transistor (MESFET), Charge Coupled Devices (CCDs), Microwave transistors, Gunn Diode, Impatt Diode.

Unit-II

Semiconductor Tunnel Devices: Tunneling from the point of view of quantum measurement, Analysis of the Tunneling effect; Tunneling probability, Tunneling current density, Resonant tunneling.

Tunnel Diodes; Qualitative and quantitative explanation of the Tunnel Diode I-V characteristics, Indirect tunneling, Excess current, Thermal current in a tunnel diode, Dependence of tunnel diode characteristics on various parameters.

Unit-III

Physics of Advance MOSFET Structures: Non-uniform Doping and Buried Channel Devices, Background on hetero-structure, Quantum well, Two-dimensional electron gas (2DEG), Super lattice, Coulomb blockade effect, Quantized transport, Ballistic transport, and Quantum capacitance.

Unit-IV

MOSFET Structures: Thin Film Transistor (TFT), Silicon on Insulator (SOI), High electron-mobility transistor (HEMT), Modulation-doped FET (MODFET), Recessed-Channel MOSFET, Floating gate MOSFET, Ballistic Transistor, Single-electron Transistor (SET), Negative Capacitor Field Effect Transistors (NC-FETs).

Unit-V

BJT Structures: Heterojunction bipolar transistor (HBT), Super lattice Devices, Planar Doped Barrier Devices, Real Space Transfer and Hot Electron Injection Transistors, Polysilicon Emitter Structure, Sidewall Base **Contact Structure, and High Frequency Transistor.**

Photonic Devices: Light-emitting diodes (LEDs), OLEDs, Laser diodes, Photodetectors, and Solar cells

State-of-the-art Semiconductor Devices: Emerging non-volatile memory materials and devices (Memristor), Carbon nanotube/nanowire, graphene, and MoS2 based electronic devices, Introduction of Neuromorphic computing.

Course Outcome: Upon Completion of the course, the students will be able to:

- Design Advance Semiconductor devices.
- Learn Technology of Modern semiconductor devices and application

Text Book:

1.S. M. Sze and Kwok K. Ng, "Physics of Semiconductor Physics (3rd)", Wiley, 2007

2.Supriyo Datta, "Quantum Transport Atom to Transistor", Cambridge University Press, 2005

Reference Book:

1. Physics of Semiconductor Devices, Michael Shur, PHI

OE-4007	Optimization Techniques	L-T-P-C:3-0-0-3

Course objective:

- To acquire the knowledge of optimization techniques and application ofunderstanding to transportation, assignment, sequencing, and scheduling problems.
- To prepare students to understand various linear and non-linear programming problems applicable in industries.

Course content:

Unit-I

Introduction: Introduction to optimization techniques; classification of optimization problem based on objective function, constraints, and variables; classical optimization techniques, constrained, unconstrained, multivariable problems.

Unit-II

Linear Programming Problem: Introduction to Linear Programming Problem (LPP), Formulation, Graphical method, corner point method, ISO profile method, Simplex and Revised simplex method, Big-M method, Two-phase method, Standard primal form and canonical form, Duality, Dual Simplex Method.

Unit-III

Post Optimality Analysis: Sensitivity analysis; change in technological coefficients, costs and availabilities; Addition of new variable and constraints; Deletion of constraints and variable.

Unit-IV

Optimization Problems: Formulation of transportation problem, basic feasible solution, North-West corner method, Least cost entry method, Vogal's approximation method, Test of optimality. Formulation of Assignment problem, Hungarian algorithm, travelling salesman problem. Sequencing problem with jobs and machines. Project scheduling, network diagrams, critical path method, time cost optimization algorithm.

Unit-V

Non-Linear Programming Problem: Unconstrained non-linear programming problems; direct search methods – univariate method, pattern search method; Indirect search methods – steepest descent method; constrained optimization problems; direct method – complex method, Zoutendijk method; indirect method – transform techniques, penalty function method.

Course outcome:

After studying this course, the students will be able to

- understand importance of optimization of industrial process management.
- apply basic concepts of mathematics to formulate an optimization problem.
- Model engineering minima/maxima problems as optimization problems.
- analyze and appreciate variety of performance measures for various optimization problems.

Text Book:

1. Rao S. S., 'Engineering Optimization, Theory and Practice' - New Age International Publishers.
2. Chander Mohan, Kusum Deep, "Optimization Techniques", New Age International Private Limited.
3. S. K. Yadav, S. R. Yadav, A. K. Malik, "Optimization Techniques", I K International Publishing House.

Reference Book:

1. E. K. P. Chong and S. Zak, "An introduction to optimization" John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
2. R. Fletcher, "Practical methods of optimization", Wiley, New York.
3. J. Nocedal and S. Wright, "Numerical optimization", Springer-Verlag, New York.
4. R. K. Sundaram, "A first course in optimization theory", Cambridge University Press, Cambridge.

OE-4009	Research Methodology & Intellectual Property Rights	L-T-P-C:3-0-0-3

Course objective:

- Present research methodology and the technique of defining a research problem.
- Learn the meaning of interpretation, techniques of interpretation, precautions is to be taken in interpretation for research process,
- Application of statistical methods in research
- Learn intellectual property rights and its constituents.

Course content:

Unit-I

Introduction to research, Definitions and characteristics of research, Types of Research, Research

Process, Problem definition, Objectives of Research, Research Questions, Research design, Quantitative vs. Qualitative Approach, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs. Theoretical Research, Importance of reasoning in research.

Unit-II

Problem Formulation, Understanding Modeling & Simulation, Literature Review, Referencing, Information Sources, Information Retrieval, Indexing and abstracting services, Citation indexes, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Interpretation of Results.

Unit-III

Statistics: Probability & Sampling distribution, Estimation, Measures of central Tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Hypothesis testing & application, Correlation & regression analysis, Orthogonal array, ANOVA, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One way and two way classified data, 'F'-test.

Unit-IV

Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents.

Unit-V

Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science.

Course outcome:

- Design and formulation of research problem.
- Analyze research related information and statistical methods in research.
- Carry out research problem individually in a perfect scientific method
- Understand the filing patent applications- processes, Patent search, and various tools of IPR, Copyright, and Trademarks.

Text Book:

1. K. S. Bordens, and B. B. Abbott, , "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
3. Douglas C. Montgomary & George C. Runger, Applied Statistics & probability for Engineers, 3rd edition,2007,Wiley
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, and "Intellectual Property in New Technological Age". Aspen Law & Business; 6th edition July 2012

Reference Book:

1. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.
3. G.W. Snedecor and W.G. Cochrans, Lowa, Statistical Methods, state University Press, 1967.
4. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.

OE-4011	Antenna Design	L-T-P-C:3-0-0-3

Module I

Antenna Fundamentals: Introduction, Types of Antennas, Radiation Pattern and mechanism, Antenna Parameters, Antenna Losses, Duality Theorem, Reciprocity Theorem.

Module II

Elementary Antennas: Linear Wire Antennas, Monopole, Infinitesimal Dipole, Small Dipole, Finite Length Dipole, Half Wavelength Dipole, Loop Antenna, Small Circular Loop.

Module III

Aperture and Broadband Antennas: Huygens' Principle, Radiation from Rectangular and Circular Apertures, Babinet's Principle, E-Plane and H-Place Sectorial Horn, Pyramidal Horn, Conical Horn, Broadband Antennas.

Module IV

Microstrip Antennas: Basic Characteristics of Microstrip Antennas, Antenna Miniaturization, Feeding Methods, Introduction to Patch and its types, Methods of Analysis, Design of Rectangular and Circular Patch Antennas. Quality Factor, Bandwidth, Efficiency.

Module V

Reflector and Smart Antennas: Plane, Corner, Parabolic and Spherical Reflector, Introduction to Smart Antennas, Switched Beam Systems, Adaptive Array Systems, Spatial Division Multiple Access, MANETs.

Text Book:

1. Balanis C.A., "Antenna Theory and Design", 3rd Edition, John Wiley & Sons. 2005, ISBN: 978-81-265-2422-8.

Reference Book:

1. Stutzman W.L., and Thiele G.A., "Antenna Theory and Design", 2nd Edition. John Wiley & Sons. 1998.
2. Elliot R.S., "Antenna Theory and Design", Revised Edition, Wiley-IEEE Press, 2003.

OE-4013	Data Mining	L-T-P-C:3-0-0-3

Course objective:

- To learn embedded system architecture.
- Study in detail process management and memory management.
- To learn Real Time Operating system principles and its components.
- Study in detail Linux kernel and Linux files systems.
- Study in detail device drivers.

Course Content:

Unit 1: General Introduction of Warehousing: Historical Perspective, characteristics of data warehousing. Data Warehousing: its architecture, Logical design, Data Preprocessing- Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Data Discretization and Concept hierarchy generation

Unit 2: Multidimensional data model, Attribute oriented induction, Overview of ETL and OLAP, Comparison of OLAP and OLTP systems, Data mart. Data mining vs Database, Data Warehousing architecture and implementation, Data mining as a component of data warehouse.

Unit 3: Data Mining Techniques: Basic concepts of Association Rule Mining, Frequent Item set mining, Mining various kinds of association rules, Classification by decision tree induction

Unit 4: Bayesian Classification, Rule-based Classification, Classification Back-propagation, Associative Classification, Lazy Learners, Rough set approach, Clustering methods

Unit 5: Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Measuring Data Similarity and Dissimilarity Partition based Clustering, Hierarchical based clustering, Density based clustering.

Course Outcome:

On completion of the course, student will be able to

- Understand formal machines, languages
- Understand stages in building a Data Warehouse
- Apply pre-processing techniques for data cleansing
- Analyse multi-dimensional modelling techniques
- Analyse and evaluate performance of algorithms for Association Rules
  Analyse Classification and Clustering algorithms

Text Book:

1. Arun K. Pujari, Data Mining Techniques, University Press, 2001
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. Paulraj Ponniah, Data Warehousing: Fundamentals for IT Professionals, Wiley Pb. Linux", Packt Publishing, 1st Edition, 2017.

Reference Book:

1. Jiawei Han and M Kamber , Data Mining Concepts and Techniques, , Second Edition, Elsevier Publication, 2011.

OE-4015	**Software Project Process and Quality Management**	**L-T-P-C:3-0-0-3**

Course objective:

- To learn the basic project attributes such as size, effort, cost etc.
- To get an overview of the project planning activities and organization of the project plan document.
- To learn the different project estimation and scheduling techniques.
- To know project risk and configuration management.

Course content:

Unit 1

Introduction to S/W project management, S/W project management competencies, responsibilities of a software project manager, Software process, S/W process models, project planning, organization of project team.

Unit 2

Estimation Techniques: S/W size estimation, estimation of effort & duration. COCOMO models, Putnam's work, Jensen's model, Halstead's software Science.

Unit 3
Dependency & scheduling: PERT, CPM, Gantt Chart, staffing, Organizing a software engineering project.

Unit 4
S/W configuration management, monitoring & controlling S/W projects, developing requirements, risk management, project tracking & control, communication & negotiating.

Unit 5
S/W quality, S/W quality engineering, defining quality requirements, quality standards, practices & conventions, ISO 9000, ISO 9001, S/W quality matrices, managerial and organization issues, defect prevention, reviews & audits, SEI capability maturity model, PSP, six sigma.

Course outcome:
After reading this subject, students will be able to:

- Understand basic project attributes such as size, effort, cost etc.
- Learn the desirable responsibilities of a good project manager.
- Measure length , volume, effort, time and cost of a project.
- Schedule project activities using PERT and GANTT chart.
- Handle various project risks and configuration management.

Text Book:

1. B. Hughes, M. Cotterell, Rajib Mall, Software Project Management, McGraw Hill , 2015
2. R. Walker, Software Project Management, Pearson , 2003

Reference Book:

1. R. H. Thayer, Software Engineering Project management, IEEE CS Press , 1988
2. R. Pressman, Software Engineering: A Practitioner's approach, McGraw Hill , 2005

OE-4019	Advanced Computer Networks	L-T-P-C:3-0-0-3

Course content:

Unit 1
IPv6: The next generation internet – trend of the future and many other aspects. The basic IPv6 protocol with its new auto-configuration scheme. The transition technologies for moving from IPv4 to IPv6.

Unit 2
Mobile IP and Mobile IPv6. Basic mobile IPv4 protocol and triangular and optimized routing. Mobile IPv6 protocol and difference from mobile IPv4.

Unit 3
Traffic Engineering (TE)/Quality of Service(QOS) in IP: Considering the latest trend towards VoIP. Basic concepts of QoS and the various proposals to achieve QoS: diffserv and intserv. MPLS and how it is useful in QoS. Basic concepts of traffic engineering and how this can be achieved with MPLS.

Unit 4
Software Defined Networking (SDN): Motivation for introducing SDN, Data plane abstraction, control

plane abstraction and network virtualization concepts. (This is entirely based on research papers as of now.)

Course outcome: At the end of this course, student will able to

- Understand the IPv6 and its implementation.
- Understand various mobile IP allocation and use-cases.
- Understanding network traffic engineering and Quality of Service.
- Understanding the new era of networking as SDN.

Text Book:

1. TCP/IP Protocols Suits, Behrouz A. Forouzan, Mc Graw Hill

Reference Book:

1. RFCs for IPv6 and Microsoft documents on IPv6.
2. Mobile IP, Design Principles and Practices by Charles Perkins
3. Mobile IPv6 by Hesham Soliman
4. MPLS and Label Switching Networks by Uyless Black
5. MPLS by Bruce Davie and Yakov Rekhter
6. QoS control in High Speed Networks by H.Jonathan Chao, Xiaolei Guo
7. SDN Papers

OE-4021	Cyber Crime	L-T-P-C:3-0-0-3

Course content:

Unit 1: Cyber Crime- Overview, Internal and External Attacks, Attack Vectors. Cybercrimes against Individuals – E-mail spoofing and online frauds, Phishing and its forms, Spamming, Cyber-defamation, Cyberstalking, Cyber Bullying and harassment, Computer Sabotage, Pornographic offenses, Password Sniffing. Keyloggers and Screenloggers. Cyber Crimes against Women and Children.

Unit 2: Cybercrime against organization – Unauthorized access of computer, Password Sniffing, Denial-of-service (DOS) attack, Backdoors and Malwares and its types, E-mail Bombing, Salami Attack, Software Piracy, Industrial Espionage, Intruder attacks.

Security policies violations, Crimes related to Social Media, ATM, Online and Banking Frauds. Intellectual Property Frauds. Cyber Crimes against Women and Children.

Unit 3: A global perspective on cybercrimes, Phases of cyber attack – Reconnaissance, Passive Attacks, Active Attacks, Scanning, Gaining Access, Maintaining Access, Lateral movement and Covering Tracks. Detection Avoidance, Types of Attack vectors, Zero-day attack, Overview of Network based attacks.

Unit 4: Cybercrime and cloud computing, Different types of tools used in cybercrime, Password Cracking – Online attacks, Offline attacks, Remote attacks, Random Passwords, Strong and weak passwords. Viruses and its types. Ransomware and Cryptocurrencies. DoS and DDoS attacks and their types. Cybercriminal syndicates and nation state groups.

Course outcome: At the end of this course, student will able to

- Analyze and evaluate the cyber security needs of an organization.
- Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
- Measure the performance and troubleshoot cyber security systems.
- Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
- Comprehend and execute risk management processes, risk treatment methods, and key risk and

performance indicators

- Design and develop a security architecture for an organization.
- Design operational and strategic cyber security strategies and policies.

Text Book:

1. William Stallings; "Cryptography and Network Security: Principles and Practices", Fifth Edition, Prentice Hall Publication Inc., 2007.
2. Atul Jain; "Cyber Crime: Issues, Threats and Management", 2004.

Reference Book:

1. Nina Godbole and Sunit Belapore; "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publications, 2011.
2. Shon Harris, "All in One CISSP, Exam Guide Sixth Edition", McGraw Hill, 2013.
3. Bill Nelson, Amelia Phillips and Christopher Steuart; "Guide to Computer Forensics and Investigations" – 3 rd Edition, Cengage, 2010 BBS.

CS-4023	**Advances In Software Testing**	**L-T-P-C:3-0-0-3**
Course objective:	• To learn the evolution of software testing techniques, Myths and facts of software testing, Models for testing processes, various types of software testing. • To design test cases using black-box and white-box testing techniques. • To understand basic concepts of regression testing, Problems of regression testing, and types of Regression testing techniques. • To learn the strategies for testing of object-oriented applications and web-based applications.	

Course content:

UNIT-1

Introduction to software testing, Basic concepts, Verification and Validation, Black box testing: Boundary value testing, Equivalence class testing, State Table Based Testing,Decision Table Based Testing, Cause-Effect Graph based Testing, Positive and Negative Testing, Orthogonal Array Testing.

UNIT-2

White box testing: statement coverage, Branch coverage, condition coverage, MC/DC, path coverage, McCabe's cyclomatic complexity Data flow based testing, Mutation testing.

UNIT-3

Static testing, Integration testing, System testing, Interaction testing, Performance testing, Regression testing, Error seeding, Debugging.

UNIT-4 Object-oriented software testing: issues in object-oriented testing, Fault based testing, test cases and class hierarchy, Scenario based Test design, Class testing: Random testing for object-oriented classes, Partition testing at the class level Inter class test case design: multiple class testing, tests derived from behavioral models, Testing web based systems, Testing tools.	
Course outcome:	After reading this subject, students will be able to: • Understand the evolution of software testing techniques, their goals and learn the various models of software testing. • Generate test cases for software systems using black box and white box testing techniques. • Carry out regression testing of software systems. • Test conventional, object-oriented and web based software. • Understand debugging software and types of debuggers.
Text Book:	1. C. J. Paul, Software testing: A craftsmen's approach, CRC Press , 2013 2. S. Desikan, R. Gopalswamy, Software Testing: Principles and Practices, Pearson , 2006
Reference Book:	1. N. Chauhan, Software Testing: Principles and Practices, Oxford University Press , 2017 2. G. J. Myers, The art of software testing, Wiley Interscience New York , 2011

CS-4025	**Soft Computing**	**L-T-P-C:3-0-0-3**
Course objective:	• Understand Soft Computing concepts, technologies, and applications • Understand the underlying principle of soft computing with its usage in various application. . • Understand different soft computing tools to solve real life problems.	
Course content: **UNIT-1** Overview of Soft Computing, Difference between Soft and Hard computing, Brief descriptions of different components of soft computing including Artificial intelligence systems Neural networks, fuzzy logic, genetic algorithms. Artificial neural networks Vs Biological neural networks, ANN architecture, Basic building block of an artificial neuron, Activation functions, Introduction to Early ANN architectures (basics only)-McCulloch & Pitts model, Perceptron, ADALINE, MADALINE **UNIT-2**		

Artificial Neural Networks: Supervised Learning: Introduction and how brain works, Neuron as a simple computing element, The perceptron, Backpropagation networks: architecture, multilayer perceptron, backpropagation learning-input layer, accelerated learning in multilayer perceptron, The Hopfield network, Bidirectional associative memories (BAM), RBF Neural Network.

UNIT-3

Artificial Neural Networks: Unsupervised Learning: Hebbian Learning, Generalized Hebbian learning algorithm, Competitive learning, Self- Organizing Computational Maps: Kohonen Network.

UNIT-4

Fuzzy Logic Crisp & fuzzy sets fuzzy relations fuzzy conditional statements fuzzy rules fuzzy algorithm. Fuzzy logic controller.

UNIT-5

Genetic algorithms basic concepts, encoding, fitness function, reproduction-Roulette wheel, Boltzmann, tournament, rank, and steady state selections, Convergence of GA, Applications of GA case studies. Introduction to genetic programming- basic concepts.

Course outcome:	Upon successful completion of this course students should be able to: • Develop application on different soft computing techniques like Fuzzy, GA and Neural network • Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.

Text Book:

1. R. Rajasekaran and G. A and Vijayalakshmi Pa, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, Prentice Hall of India
2. D. E. Goldberg, Genetic Algorithms in Search, Optimisation, and Machine Learning, Addison-Wesley

Reference Book:

1. L. Fausett, Fundamentals of Neural Networks, Prentice Hall
2. T. Ross, Fuzzy Logic with Engineering Applications, Tata McGraw Hill

OE-4027	**Pattern Recognition and Classification**	**L-T-P-C:3-0-0-3**

Course objective:

The objective of the course is to understand the algorithms for Pattern Recognition. The representation of patterns and classes and the similarity measures are an important aspect of pattern recognition. Pattern recognition involves classification and clustering of patterns. The two well-known paradigms of machine learning namely, learning from examples or supervised learning and learning from observations or clustering covered in this course. When the data sets are very large it is meaningful to reduce the data and use this reduced data for pattern classification. The details of feature extraction and

feature selection are also covered in this course.

Course content:

Unit 1: Introduction: Basics of Probability and Statistics, Linear Algebra, Linear Transformations, Components of Pattern Recognition System, Learning and adaptation, Supervised Learning (Classification) and Unsupervised Learning (Clustering)

Unit 2: Bayesian Decision Theory: classifiers, discriminant functions, decision surfaces, Discriminant functions for Normal density, Error bounds for Normal density, Maximum Likelihood and Bayesian Parameter Estimation, Principal Component Analysis, Fisher Linear Discriminant, Hidden Markov Models.

Unit 3: Non-parametric Techniques: Parzen window estimation, *k*-nearest neighbour classification, Perceptron classifier, Support Vector Machines, Decision Tree based classifiers

Unit 4: Back propagation networks : (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input – hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.

Basic functional units of ANN for pattern recognition tasks: Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.

Unit 5: Competitive learning neural networks : Components of CL network pattern clustering and feature. Mapping network, Unsupervised Learning/Clustering: distance/similarity measures, K-means clustering, single linkage and complete linkage clustering. Applications of ANN.

Course outcome:

At the end of the course student will be able to

- design systems and algorithms for pattern recognition
- analyze a given pattern recognition problem, and determine which algorithm to use
- modify existing algorithms to engineer new algorithms
- solve a particular problem at hand from a wide variety of application domains
- gain a working knowledge of some of the most recent developments in pattern recognition, such as incremental learning and learning in nonstationary environments

Text Book:

1. Pattern Recognition and Machine Learning, C. M. Bishop
2. Artificial Neural Network, B. Yegnarayana

Reference Book:

1. Pattern Classification, R. O. Duda, P. E. Hart, D. G. Stork

OE-4029	**Machine Learning**	**L-T-P-C:3-0-0-3**

Course objective:

- Machine learning uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention.
- Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc.
- This class will familiarize students with a broad cross-section of models and algorithms for machine learning, and prepare students for research or industry application of machine learning techniques.

Module I

Based on fundamental knowledge of computer science principles and skills, probability and statistics theory, and the theory and application of linear algebra. This course provides a broad introduction to machine learning and statistical pattern recognition.

Module II

Supervised learning (generative/discriminative learning parametric/nonparametric learning, neural networks, and support vector machines);
Unsupervised learning (clustering, dimensionality reduction, kernel methods);
Learning theory (bias/variance tradeoffs; VC theory; large margins);
Reinforcement learning and adaptive control.

Module III

Applications of machine learning, such as to robotic control, data mining, autonomous navigation, speech recognition.

Module IV

Bioinformatics, NLP, Text and web data processing.

Course outcome:

Develop an appreciation for what is involved in learning models from data.

- Understand a wide variety of learning algorithms.
- Understand how to evaluate models generated from data.
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Text Book:

1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition. http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012. This book will cover all the material in the course.

Reference Book:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning.

3. Tom Mitchell, Machine Learning, http://www.cs.cmu.edu/~tom/mlbook.html.

OE-4031	Computer Vision	L-T-P-C:3-0-0-3

Course objective:

- Be familiar with both the theoretical and practical aspects of computing with images;
- Have described the foundation of image formation, measurement, and analysis;
- Have implemented common methods for robust image matching and alignment;
- Understand the geometric relationships between 2D images and the 3D world.
- Have gained exposure to object and scene recognition and categorization from images;
- Able to develop the practical skills necessary to build computer vision applications.

Course content:

Unit-I

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Unit-II

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Unit-III

Shape Representation, Segmentation and Object Recognition: Shape Representation and Segmentation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and Wavelet Descriptors, Medial Representations ,Multiresolution analysis, Hough transforms and other simple object recognition Methods, Shape Correspondence and Shape Matching, Shape priors for recognition.

Unit-IV

Motion Estimation: Regularization Theory, Optical Computation, Stereo Vision, Motion Estimation, Structure from Motion.

Course outcome:

- Able to demonstrate knowledge and understanding of Human and computer vision systems.
- Understand current approaches to image formation and image modeling.
- Analyze and design a range of algorithms for image processing and computer vision
- Develop and evaluate solutions to problems in computer vision

Text Book:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.

4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

5. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Reference Book:

1. IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).

2. IJCV (International Journal of Computer Vision) - Springer.

OE-4033	Cloud Computing	L-T-P-C:3-0-0-3

Course objective:

- To impart basic concepts in the area of cloud computing.
- Bring in-depth understanding on architectures and models for Cloud Computing with Internet of Things.
- To impart knowledge in web-based applications of cloud computing

Course content:

Unit 1: Introduction to Cloud Computing: Nutshell of cloud computing, feature Characteristics and components of Cloud Computing. Challenges, Risks and Approaches of Migration into Cloud. Evaluating the Cloud's Business Impact and economics, Future of the cloud.

Unit 2: Networking Support for Cloud Computing. Ubiquitous Cloud and the Internet of Things. Cloud Computing Architecture: Cloud Reference Model, Layer and Types of Clouds, Services models, Data center Design and interconnection Network, Architectural design of Computer and Storage Clouds.

Unit 3: Cloud Programming and Software: Fractures of cloud programming, Parallel and distributed programming paradigms, High level Language for Cloud. Introduction to Map Reduce, GFS, HDFS, Hadoop Framework.

Unit 4: Virtualization Technology: Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms, Hypervisor, VMware, KVM, Xen. Virtualization of CPU, Memory, I/O Devices, Virtual Cluster and Resources Management, Virtualization of Server, Desktop, Network, and Virtualization of data-center.

Unit 5: Web-Based Application, Pros and Cons of Cloud Service Development, Types of Cloud Service Development, Software as a Service, Platform as a Service, Web Services, On-Demand Computing, Discovering Cloud Services, Development Services and Tools, Amazon Ec2, GoogleApp Engine, IBM Clouds.

Course outcome:

At the end of the course student will be able

- Have an overall understanding on various hardware and software necessary for cloud computing.
- Design and develop various cloud computing applications.

Text Book:

1. Cloud Computing: Principles and Paradigms, Raj Kumar Buyya, JemesBroberg, Andrzej M.Goscinski.
2. Dan C Marinescu, Cloud Computing, Theory and Practice, MK, Elsevier

Reference Book:

1. Distributed and Cloud Computing : Kai Hawang, Geoffrey C. Fox, Jack J. Dongarra

OE-4035	Statistical Mechanics	L-T-P-C:3-0-0-3

Module I

Probability concept: One dimensional random walk problem and any other relevant examples; Different probability distributions: Binomial, Gaussian and Poisson distributions and their region of validity.

Module II

Concepts of ensemble and microstates (Quantum and Classical):Phase space, phase cell; Counting of microstates for some examples (using both quantum and classical concepts); Postulate of equal a priori probability; Liouville's theorem; Ergodic hypothesis; Boltzmann H-theorem. Different types of interactions: Thermal interaction, mechanical interaction, Diffusion.

Module III

Ensembles: Microcanonical ensemble; Canonical ensemble; Grand canonical ensemble. Equipartition and virial theorems. Gibbs paradox.

Module IV

Quantum Statistics: quantum mechanical ensemble theory for all ensembles, Wave function for quantum many body system (Bosons and Fermions).

Quantum gases: Ideal Bose gas, Bose-Einstein condensation, black body radiation, phonons; Ideal Fermi gas, Pauli paramagnetism, thermionic emissions, white dwarf.

Module V

Critical Phenomena: Van der Waals equations of state and phase transition, critical exponents, Landau model, one dimensional Ising model and its solution by transfer matrix method.

Text Books:

1. Federic Reif, ``Fundamentalsof Statistical and thermal physics.'', Sarat Book Distributors, 2010.
2. R. K. Pathria, ``Statistical mechanics.'', 3rd Ed, Elsevier, 2011.
3. Nigel Goldenfeld, ``Lectures on phase transitions and the renormalization group.'', Sarat Book House, 2005.

Reference Books:

1. M. Toda, R.K. Kubo and N. Saito, ``Statistical Physics I.'', Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd ed, 1998 edition.
2. H. Eugene Stanley, ``Introduction to Phase transitions and critical phenomena.''
3. W. Greiner, L Neise, and H. Stocker, ``Thermodynamics and Statistical Mechanics.'

OE-4037	Lasers and Ultrafast Optics	L-T-P-C:3-0-0-3

Module I

Laser Physics: The Einstein coefficients, light amplification, the threshold condition, laser rate equations, line broadening mechanisms, cavity modes, optical resonator, quality factor, mode selection, Introduction to gas lasers, solid state lasers, and semiconductor lasers.

Module II

Ultrafast optics: Introduction to ultrashort pulses (nano-, pico-, femto-, attosecond pulses): generation and propagation; principles of mode locking; pulse compression; laser amplifiers; interferometric autocorrelation; ultrafast measurement techniques: time resolved measurement, electro-optic sampling.

Module III

Applications: Nonlinear optical susceptibilities, second harmonic generation, self-focusing;, Step index and graded index optical fibers, attenuation and dispersion, brief introduction to fiber optic communications; Optical solitons,working principle: terahertz spectroscopy, laser ablation, multiphoton absorption.

Text Books:

1. W. T. Silfvast, Laser Fundamentals, 2nd Ed., Cambridge University Press, 2004.
2. B.E.A. Saleh and M.C.Teich, Fundamentals of Photonics, 2nd Ed., Wiley, 2007.

Reference Books:

1. Ultrafast Optics -Andrew Weiner (John Wiley & Sons).
2. Ultrashort Laser Pulse Phenomena -J.-C. Diels and W. Rudolph (Academic Press).
3. R.W. Boyd, Nonlinear Optics, 3rd Ed., Academic Press, 2007.
4. A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press, 2009.

Hons. Elective III (seventh semesters)

CS-4003	Natural Language Processing	L-T-P-C:3-1-0-4
Course objective:	• To develop a good understanding of all aspects of Natural Language Processing (NLP) from both linguistic and statistical point of view and to provide solid grounding in selected topics.	

Course content:

Unit I: Introduction, origins and history, Natural Language Processing tasks in syntax, semantics, and pragmatics, Issues, Applications - The role of machine learning, Probability Basics –Information theory, Collocations, N-gram Language Models, Estimating parameters and smoothing, Evaluating language models.

Unit II: Current status and future challenges. Corpus processing, computational lexicography, morphology and syntax with an emphasis on English as well as Indian

	Languages. Markov Models, Hidden Markov Models, Transformation based Models, Maximum Entropy Models, Conditional Random Fields **Unit III:** Syntax Parsing - Grammar formalisms and treebanks, Parsing with Context Free Grammars, Features and Unification, Statistical parsing and probabilistic CFGs (PCFGs), Lexicalized PCFGs **Unit IV:** Semantic Analysis: Representing Meaning, Semantic Analysis, Lexical semantics, Word-sense disambiguation, Supervised, Dictionary based and Unsupervised Approaches, Compositional semantics-Semantic Role Labelling and Semantic Parsing, Discourse Analysis **Unit V:** Applications to MT, NL interfaces, Information Retrieval (IR), etc. Named entity recognition and relation extraction- IE using sequence labelling-Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation – Question Answering
Course outcome:	• To understand the use of CFG and PCFG in NLP • To understand the role of semantics of sentences and pragmatics • To apply the NLP techniques to IR applications
Text Book:	1. James Allen: Natural Language Understanding, The Benjamin/Cummings Publishing Co, Inc. 2. Daniel Jurafsky and James H. Martin Speech and Language Processing (2nd Edition), Prentice Hall; 2 edition, 2008
Reference Book:	1. Eugene Cherniak: Statistical Language Learning, MIT Press, 1993. 2. Michael P. Oakes: Statistics for Corpus Linguistics, Edinburgh University Press, 1998. 3. NLTK – Natural Language Tool Kit - http://www.nltk.org/ 4. Pierre M. Nugues, An Introduction to Language Processing with Perl and Prolog: An Outline of Theories, Implementation, and Application with Special Consideration of English, French, and German (Cognitive Technologies) Softcover reprint, 2010

CS-4005	**Quantum Computing**	**L-T-P-C:3-1-0-4**
Course objective:	• To study the mathematics and computer science aspect of quantum computing • To study the basics of linear algebra and computer science needed to understand the theory of quantum computation. • To learn about quantum circuit model in which most of the quantum algorithms are designed. • To look at quantum algorithms and the advantage they offer over classical counterparts.	
Course content: **Unit 1: Foundations of quantum theory:** States, observables, measurement and unitary evolution. Qubits versus classical bits, spin-half systems and photon polarisations. Pure and mixed states, density matrices. **Unit 2: Background Mathematics and Physics:** Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum		

mechanics, Measurements in bases other than computational basis. Introduction to classical information theory and generalization to quantum information.

Unit 3: Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits. Turing machines and computational complexity. Reversible computation. Universal quantum logic gates and circuits.

Unit 4: Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. Quantum error correction, fault-tolerant computation. Physical implementations of quantum computers.

Unit 5: Quantum algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, database search, FFT and prime factorization. Simon's algorithm, The prime factorization algorithm, Grover's search algorithm

Course outcome:	• Students would learn the framework of quantum computation, and how that may be useful for future quantum technologies
Text Book:	4. *Quantum Computation and Quantum Information* – Nielsen, Michael A., and Isaac L. Chuang. Cambridge, UK: Cambridge University Press, September 2000. ISBN: 9780521635035. 5. *Quantum Theory: Concepts and Methods* – Peres, Asher. New York, NY: Springer, 1993. ISBN: 9780792325499.
Reference Books:	9. An Introduction to Quantum Computing – P Kaye, R Laflamme and M Mosca. 10. Linear Algebra and its Applications – G. Strang. 11. Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics – Benenti G., Casati G. and Strini G., World Scientific. 2004 12. An Introduction to Quantum Computing Algorithms – Pittenger A. O.

CS-4007	Humanoid Robotics	L-T-P-C:3-1-0-4

Course objective:

- Describe the different physical forms of robot architectures.
- Kinematically model simple manipulator and mobile robots.
- Mathematically describe a kinematic robot system.
- Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, control, and uncertainty.

UNIT I-Introduction History of robots,

Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

UNIT II- Drive systems and Sensors

Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

UNIT III-Kinematics and Dynamics of Robots

2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneious Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representationof robots, Basics of Trajectory Planning.

UNIT IV-Robot Control,

Programming and Applications Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples. Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.

Course Outcome:

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

- Compute forward and inverse kinematics for a small serial kinematic chain.
- Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
- Perform stability analysis of a controller-robot system, and describe why it is important.
- Model uncertainty in robot processes.

Text Book:

[1] Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
[2] Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Book:

[1]S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
[2] Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.

CS-4009	**Advanced Database Management Systems**	**L-T-P-C:3-1-0-4**
Course objective:	• To evaluate emerging architectures for database management systems. • To develop an understanding of the manner in which relational systems are implemented and the implications of the techniques of implementation for database performance. • To assess the impact of emerging database standards on the facilities which future database management systems will provide.	

Course content:

UNIT-1 Theoretical concepts, Relational model conformity and Integrity, Advanced SQL programming

UNIT-2 Query optimization, Concurrency control and Transaction management, Database performance tuning, Distributed relational systems and Data Replication

UNIT-3 Object oriented, deductive, spatial, temporal and constraint database management systems, New database applications and architectures: e.g. Data Warehousing; Multimedia; Mobility; NoSQL, Native XML databases (NXD), Document orientated databases

UNIT-4 SQL standards development, Standards for interoperability and integration e.g. Web Services

UINT-5 Database security - Data Encryption, redaction and masking techniques. Authentication and authorization. Database auditing

Course outcome:	After reading this subject, students will be able to: • Critically assess new developments in database technology • Interpret and explain the impact of emerging database standards • Evaluate the contribution of database theory to practical implementations of database management systems.

Text Book:

1. Date C. J., An Introduction to Database Systems, AddisonWesley Longman (8th Ed), 2003
2. Silberschatz A., Korth H., and Sudarshan S., Database System Concepts, McGraw-Hill (6th Ed), 2010

Reference Book:

3. Melton, J., & Simon A., SQL 1999, Understanding Relational Language Components, Morgan-Kaufmann, 2003.
4. Peter Adams : SQL: The Ultimate Guide from Beginner to Expert - Learn and Master SQL in No Time, Addison Wesley, 2016

CS-4011	**Big Data Analytics**	**L-T-P-C:3-1-0-4**
Course objective:	• To gain an understanding of Relational Database Management Systems • To gain an understand and use Structured Query Language • To gain an understanding of Data Analytics and Visualization • To gain an understanding of how managers use analytics to formulate and solve business problems and to support managerial decision making.	

Course content:

UNIT-1

Understanding Relational Database Management Systems; The databse Normalization process; Implementation of Referential Integrity; Using SQL Data Manipulation

Language (DML): Used to retrieve, update and delete contents of a database; Using SQL Data Definition Language (DDL): Used to create database objects such as tables, stored procedures, cursors, indexes, etc. Using SQL Queries: Using SQL syntax to execute queries; and getting and using data result sets;

UNIT-2

Understand summary statistics of a data set, including sizes, ranges and variations.

UNIT-3

Interpret the business significance of the data, what it implies about the business, customers, etc.

UINT-4

Generating reports on the data, including appropriately constructed graphics and histograms that illustrate important features of the data.

UNIT -5

Machine Learning Algorithms Application in Data Analysis

Course outcome:	Upon successful completion of this course students should be able to: • These conclusions are made possible by using the various analytic tools currently available, i.e. MS Power • Business Intelligence(BI), Hadoop, Tableau, Excel, SAS, etc.

Text Book:

1. Business Intelligence Guidebook - From Data Integration to Analytics, First Edition, Rick Sherman
2. Morgan Kaufmann; 1 edition (November 21, 2014), 550 pages
ISBN-10: 012411461X | ISBN-13: 978-0124114616 |