# B.Tech ECE electives Syllabus

## Hons. Elective I (fifth semester)

| EC-3007 | Computational Intelligence | L-T-P-C:3-1-0-4 |
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**Course objective:**

- To provide a strong foundation on fundamental concepts in Computational Intelligence.
- To enable Problem-solving through various searching techniques.
- To apply these techniques in applications which involve perception, reasoning and learning.
- To apply Computational Intelligence techniques for information retrieval and machine learning

**Module I**

Introduction to soft computing : Soft computing constituents and conventional Artificial intelligence, soft computing characteristics;

**Module II**

Fuzzy Sets, Fuzzy Rules and Fuzzy reasoning : Introduction, Basic definitions and terminology; Set theory operations : Fuzzy union, Intersection and Complement, Extension principal and fuzzy relations, Fuzzy IF rules, MF formulation and parameterization; Fuzzy interference System : Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models;

**Module III**

Artificial Neural Network : Supervised Learning Neural Network, Preceptron, Adaline, multi-layer neural networks, back propagation algorithm, Radial basis function networks; Functional Link Artificial Neural network : update algorithms, trigonometric and power series expansions; Unsupervised Learning Neural Network : Competitive learning networks, Kohonen self-organizing networks, Hopfield network;

**Module III**

Introduction to NeuroFuzzy Networks : Genetic Algorithm, Adaptive Genetic Algorithm, Ant Colony Algorithm, Bacteria Foraging Algorithm, Particle Swarm Optimization; Introduction to other soft computing technique.

**Text Book:**

1. Neuro-Fuzzy and soft Computing –J.S.R. Jng, C.T.Sun and E.Mizutani, PHI.
2. Neural Networks A Comprehensive foundation-Simon Haykin, Pearson Education.

**Reference Book:**

1. Neutral Networks, Fuzzy Logic and Genetic Algorithm Rajasekaran, G.A. Vijayalaksmi, PHI.

| EC-3009 | Optical Sensors | L-T-P-C:3-1-0-4 |
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**Course objective:**

- To prepare students to understand concepts of fiber optic sensor technology.
- To acquire the concept of optical sensors working principle, and to have knowledge on the various grating, magnetic, chemical and bio sensors.

**Unit-I**

**Sensor Technology:** The Emergence of Fiber Optic Sensor Technology, Optical Fibers, Light Sources, Optical Detectors, Optical Modulators, Intensity-Based and Interferometric Sensors - Fabryperot, Mach Zender, Michelson and Sagnac.

**Unit-II**

**Grating Sensors:** Multimode Grating and Polarization Sensors, Sensors Based on Relative Movement of Opposed Gratings, Grating Period Modulation, and Sensors Based on the Photoelastic Effect, Retardation Plates, Fiber Grating Sensors.

**Unit-III**

**Distributed and Magnetic Sensors:** Fiber Optic Distributed and Magnetic Sensor, Distributed Sensing, Basic Principles of Sensor Multiplexing, Interferometric Sensor Multiplexing, Faraday effect sensors, Magneto strictive, Lorentz force sensors, Evanescent Field Absorption Sensors

**Unit-IV**

**Chemical and Biosensor:** Reagent Mediated sensor, Humidity sensor, pH sensor, Hydrogen sensor, $CO_2$ sensor, Ammonia sensor, Chloride sensor, Glucose sensor, Oxygen sensor, Surface Plasmonic Resonance based sensor

**Unit-V**

**Applications:** Industrial Applications of Fiber Optic Sensors: Temperature, Pressure, fluid level, flow, position, vibration, rotation measurements, Current-voltage measurement, Chemical analysis.

**Course outcome:**

After studying this course, the students will be able to

- Describe the fundamentals of optical sensors.
- Describe the advantage and need of fiber optics sensor technology.
- Gain knowledge and understanding about real time applications of optical sensors.

**Text Book:**


1. Bishnu P. Pal, “Fundamentals of fiber optics in telecommunication and sensor systems”, Wiley Eastern.
2. Dakin J and Culshow B., “Optical fiber sensors”, Artech House.
3. Francis T.S Yu, Shizhuo Yin, “Fiber Optic Sensors”, Marcel Dekker Inc., New York.


**Reference Book:**


1. Jose Miguel Lopez-Higuera (Ed), “Handbook of optical fiber sensing technology”, John Wiley and Sons Ltd.
2. Eric Udd, William B. Spillman, Jr., “Fiber Optic Sensors: An Introduction for Engineers and Scientists”, John Wiley & Sons.

3. Francis T.S. Yu, Shizhuo Yin, Paul B. Ruffin, “Fiber Optic Sensors”, CRC Press Publisher.

| EC-3011 | Mobile Communication | L-T-P-C:3-1-0-4 |
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**Course objective:**

- To realize the vision of "Optimally Connected Anywhere, Anytime" supported by all system levels from access methods and networks to service platforms and services.
- To realize and characterize the systems beyond 3G as a horizontal communication model, where different terrestrial access levels and technologies are combined to complement each other in an optimum way for different service requirements and radio environments.

**Course content:**

**Unit-I**

An overview of cellular systems, Introduction, Mobility versus portability, Wireless communication and the layer model, First and Second Generation cellular systems, Cellular communications from 1G to 5G, Road map for higher data rate capability in 5G, Wireless 5G systems, Future wireless networks, Standardization activities for cellular systems.

**Unit-II**

Cellular system design concepts and fundamentals, Frequency reuse, Channel assignment, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular systems, Mobile radio wave propagation, Large scale path loss and propagation models, Reflection, Diffraction, Scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models.

**Unit-III**

Small scale fading and multipath propagation, Rayleigh and Ricean distributions. Multiple access techniques for wireless communications, FDMA, TDMA, Spread Spectrum multiple access, FHMA, CDMA, SDMA.

**Unit-IV**

Packet radio, Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA, Capacity of cellular systems, Wireless systems and standards, AMPS and ETACS, IS 54 and IS 136, GSM features, Architecture, Radio subsystems, Traffic channels, Call processing.

**Unit-V**

CDMA features, Architecture, IS 95, Forward and reverse channels, Power control, System capacity, Wireless Networking, WLAN, PAN, Mobile network layer, Mobile transport layer, Wireless data services, Common channel signaling, Wireless networking, Satellite data communication, Cellular data communications, UMTS system features, WiMAX, RFID.

**Course outcome:**

- Understand the evolution of cellular communication systems upto and beyond 3G
- Design a cellular link and estimate the power budget.
- Choose proper multiple accessing methods depending on channel model
- Identify traffic channels for call processing
- Calculate key performance metrics of a cellular communication system.

**Text Book:**

1. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill.

2. Schwartz, Mobile Wireless Communications, Cambridge University Press.

**Reference Book:**

1. Stallings, Wireless Communications and Networks, Prentice Hall.
2. Theodore S Rappaport, "Wireless Communications Principles and Practice", Prentice Hall.
3. Jochen, Schiller, "Mobile Communication", 2nd Edition, Pearson Education, 2008.

| EC-3013 | Semiconductor Material & Device Characterization | L-T-P-C:3-1-0-4 |
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**Course objective:**

- To learn the Measurement of Semiconducting parameters
- To realize the Electrical characterization of Junction based devices
- To understand the physical, optical and structural properties of semiconductor materials and their characterization.

**Unit I**

**Introduction to the Measurement of Semiconducting parameters**

Resistivity measurement: Four-point probe, Correction factors, Resistivity of arbitrarily shaped samples, Resistivity profiling: Anodic oxidation-four point probe, spreading resistance, contact less resistivity methods, conductivity type measurements, Carrier and doping concentration measurements: Capacitance measurements, Differential capacitance, Maximum-Minimum MOS-C capacitance, Integral capacitance. Current-Voltage measurements, Second harmonic, MOSFET substrate voltage-gate voltage, MOSFET threshold voltage.

**Unit II**

**Characterization of Junction based Devices**

Metal-Semiconductor Contacts: Contact resistance, Measurement techniques (introduction only), Hall effect and Mobility: Mobility, Conductivity mobility, Basic equations for uniform layers or wafers, Magnetoresistance mobility, MOSFET mobility: Effective mobility, field-effect mobility and Saturation mobility, Oxide and interface trapped charge: Characterization using Capacitance-Voltage curves only.

**Unit III**

**Optical Characterization**

Optical Microscopy: Resolution, Magnification, Contrast, Differential Interference Contrast, Defect etches, Ellipsometry: theory and applications, Transmission measurements: theory and instrumentation, Fourier Transform Infrared spectroscopy, Reflection Measurements, Line width measurements, Photoluminescence, PL Spectroscopy, UV-Vis Spectroscopy, Raman Spectroscopy, FTIR.

**Unit IV**

**Morphological and Structural Characterization**

Scanning Electron Microscopy (SEM), Auger Electron Spectroscopy, Electron Microprobe, Secondary Ion Mass, Spectroscopy and X-ray Photoelectron Spectroscopy (Principle, instrumentation and its applications), Transmission Electron Microscopy (TEM), Electron Beam Induced Current, LEED and RHEED, Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), High Resolution X-Ray Diffraction study (HRXRD), Scanning Probe Microscopic Analysis (SPM)

**Course outcome:**

At the end of this course students will be able to

- Understand the Engineering of the Electrical, Optical, and material characterization.

- Interpret the results obtain from different characterization technique.
- Familiar with the optical and structural characterization techniques and the related lab work

**Text Book:**

1. Dieter K. Schroder, "Semiconductor Material and Device Characterization" John Wiley & Sons, Second Edition.
2. Ayers J. E "Heteroepitaxy of Semiconductors Theory, Growth, and Characterization" (CRC Press, Taylor & Francis Group, New York, 2007),
3. D. Keith Bowen and Brain K. Tanner, "High Resolution X-ray Diffractometry a Topography" Tailor & Francis.

**Reference Book:**

1. J.W. Octon and P. Blood, "Technique of Physics, The Electrical Characterization of Semiconductors, Measurement of Minority carrier Properties", Academic Press.
2. S.M. Sze, "VLSI Technology"- McGraw Hill Publications.

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

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


| OE-3010 | Parallel and Distributed Systems | L-T-P-C:3-0-0-3 |
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**Course content:**

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.

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.
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.
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.
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.
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-3012 | Quantum Mechanics | L-T-P-C:3-0-0-3 |
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**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 |
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**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 |
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**Course content:**

**Unit I**

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

**Unit II**

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 Non unique Keys, Queries for the Keys in an Interval, Building Optimal Search Trees, Converting Trees into Lists, Removing a Tree.

**Unit III**

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 IV**

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 V**

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 |
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**Course content:**

**Unit I**

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 II**

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 III**

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 IV**

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 V**

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 | Object Oriented System Design | L-T-P-C:3-0-0-3 |
|---|---|---|

**Course content:**

**Unit I:** 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 II:** 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.

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| **Unit III:** Structural modeling classes, relationships, interfaces, class diagrams, and object diagrams, in UML. Behavioral/Functional modeling use case diagrams, sequence diagrams, in UML.<br><br>**Unit IV:** Dynamic modeling: State charts, Architectural modeling, Analysis patterns, Design patterns. Distributed object model: CORBA and COM / DCOM<br><br>**Unit V:** Object oriented database systems: Object oriented data model, query languages, storage organization and indexing techniques; object relational databases. |
| **Course outcome:**<br>This course will cover object-oriented approach to modeling, problem solving, requirement analysis, system design, system implementation, database design, system engineering and software engineering. |

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|---|---|
| **Text Book:** | 1. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall.<br>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)

| **EC-3008** | **VLSI Testing & Testability** | **L-T-P-C:3-1-0-4** |
|---|---|---|

**Course objective:**

- To provide an in-depth understanding of the testing and verification of faults affecting VLSI circuits
- To provide a basic idea on fault tolerance after testing.

**Course content:**

**Unit-I**

Physical Faults and their modeling; Stuck at Faults, Bridging Faults; Fault collapsing; Fault Simulation: Deductive, Parallel, and Concurrent Fault Simulation.

**Unit-II**

ATPG for Combinational Circuits: D-Algorithm, Boolean Differences, PODEM Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage.

**Unit-III**

PLA Testing, Cross Point Fault Model and Test Generation.

**Unit-IV**

Memory Testing- Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests; Delay Faults.
ATPG for Sequential Circuits: Time Frame Expansion; Controllability and Observability Scan Design, BILBO, Boundary Scan for Board Level Testing; BIST and Totally self-checking circuits.

**Unit-V**

System Level Diagnosis & repair- Introduction; Concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes. Reconfiguration Techniques; Yield Modeling, Reliability and effective area utilization.

**Course outcome:** After completion of the course students will be able to uunderstand testing and

verification related concepts in VLSI circuits.

**Text/ Reference Book:**


1. Abramovici, M., Breuer, M. A. and Friedman, A. D. Digital systems testing and testable design. IEEE press (Indian edition available through Jayco Publishing house), 2001.
2. Bushnell and Agarwal, V. D. VLSI Testing. Kluwer.
3. Agarwal, V. D. and Seth, S. C. Test generation for VLSI chips. IEEE computer society press.
4. Hurst, S. L. VLSI testing: Digital and mixed analog/digital techniques. INSPEC/IEE, 1999


| EC-3010 | Optoelectronics & Photonics | L-T-P-C:3-1-0-4 |
|---|---|---|

**Course objective:**

- To develop an in-depth knowledge about major building blocks of optoelectronics and photonics.
- To introduce students to a broad range of modern optoelectronic devices and applications.

**Course content:**

**Unit-I**

Review of basic principles from physics, optical wave representation, interferometers, optical resonators, wave nature of light, polarization, interference, diffraction, light source, quantum mechanical concept, review of solid state physics, review of semiconductor physics, confinement, Gaussian beams, photons and matter, energy levels.

**Unit-II**

Photon optics: interactions of photons and atoms, population inversion, spontaneous and stimulated emission; lasers: gain mechanism, rate equations, pumping, gain and gain coefficient, laser oscillation theory, laser types, power and spectral distribution, mode selection, light emitting diodes, fabry-perot lasers.

**Unit-III**

Erbium doped fiber amplifiers (EDFA), photo detectors: properties of photo detectors, photoconductors, photodiodes, and avalanche photodiodes.

**Unit-IV**

Electro-optic modulators, magneto optic devices, acoustoptic devices, optical, switching, logic devices, physical origin of nonlinear optical coefficients, optical nonlinearity, four wave mixing and optical phase conjugation.

**Unit-V**

Phototransistors and noise mechanisms, signal-to-noise analysis, modulation of optical signals, formats, and receivers, noise and detection: types of noise and distortion which affects optical signals, methods of reducing effects of noise and distortion, optimal detection methods and devices, overview of opto-electronic networks: FDDI, fiber channel, sonnet.

**Course outcome:**

- To enable the student to understand the wave nature of light, study the quantum mechanical treatment of light.
- Analyze mechanism of operation of lasers, photo detector, photo conductors, photo diodes, amplifier, modulators, phototransistor and their performance.
- To enable the student to explore effects of noise, distortion and optimal detection methods.

**Text Book:**

5. Saleh and Teich, "Fundamentals of Photonics," Wiley Inter science, 2nd edition, 2007.
6. J. Senior, "Optical Fiber Communications. Principle and Practice," Prentice Hall, 2011.
7. R P Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2004.

**Reference Book:**

1. Wilson and Hawkes, "Optoelectronics: An Introduction, 3rd. Ed., Prentice Hall, 1997.
2. A. Ghatak & K. Thyagarajan, Optical Electronics, Cambridge University Press, 2004.

| EC-3012 | DSP System Design | L-T-P-C:3-1-0-4 |
|---|---|---|

**Unit I**

Introduction to the DSP Systems: Typical DSP algorithms, DSP applications demands and scaled CMOS technologies.

DSP Architecture: Single Core and Multicore; Digital Signal Processors and the associated interface hardware and software systems

**Unit II**

Pipelining and Parallel Processing; Pipelining of FIR digital filters, Parallel Processing, Pipelining and Parallel Processing for low power

**Unit II**

DSP algorithms: Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks.

**Unit IV**:

DSP applications: in wireless and mobile communication, multimedia technology and communication, control systems, power electronics and power systems, measurement and instrumentation.

**Course outcome:** Students will have the in depth knowledge of hardware they have used, how to pipeline/parallelize the algorithms on the hardware to have either reduce the power consumption or increase the speed of operation of algorithms

**Text/ Reference Book:**

1. Rulph Chassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley, 2005
2. Keshab K Parhi, VLSI Digital Signal Processing Systems: Design and Implementation, student Edition, Wiley, 1999.
3. Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008

| EC-3014 | RF IC Design | L-T-P-C:3-1-0-4 |
|---|---|---|

**Course objective:**

- To familiarize the basic concepts in RF design on the characterization of nonlinearity, noise, scattering parameters.
- To acquaint the student will knowledge of wireless standards and their specifications.

- To impart the knowledge of different transceiver architectures and their tradeoffs.
- To introduce the design of low noise amplifiers and mixers.
- To expose the design issues in oscillators, frequency synthesizers and RF power amplifiers.

**Course content:**

**Unit-I**

**Introduction to RF and Wireless Technology**: Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology. BASIC CONCEPTS IN RF DESIGN: Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.

**Unit-II**

**Multiple Access:** Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.

**Unit-III**

**Transceiver Architectures:** General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.

**Unit-IV**

**Amplifiers, Mixers And Oscillators**: LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.

**Unit-V**

**Power Amplifiers**: General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.

**Text Book:**

4. Behzad Razavi, RF Microelectronics, 2/e, Pearson Education, 2011.

**Reference Book:**

1. Leung Bosco, VLSI for Wireless Communication, 2/e, Springer 2011.
2. Thomas Lee, Design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press, 2013

## 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:**

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

**Module I**

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.

**Module II**

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

**Module III**

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

**Module IV**

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

**Module V**

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-4017 | Advanced Computer Networks | L-T-P-C:3-0-0-3 |
|---|---|---|

**Course content:**

**Module I**

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.

**Module II**

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

**Module III**

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.

**Module IV**

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-4019 | 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" – 3rd Edition, Cengage, 2010 BBS.

| CS-4021 | 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-4023** | **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-4025 | 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.


| 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.

Activation & Synaptic Dynamics : Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks. 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: Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron -Recognition of handwritten characters.

**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 | Data Communication & Networks | L-T-P-C:3-0-0-3 |
|---|---|---|

**Course objective:**

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

- Build an understanding of the concepts of computer networking and internet protocols.
- Familiarize with the basic taxonomy and terminology of digital and analog transmission used in computer networking area.
- Introduce the student to fundamental networking concepts with various multiplexing techniques and the importance of error correcting codes in data transmission.
- Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

**Module I**

**Introduction to Data Communication & Networks:** Data communication: components of a data communications system, data flow; networks: network criteria, physical structures, network

topology, transmission modes: parallel, serial; categories of networks - Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN); organization of the internet, internet service providers (ISPs).

**Module II**

**Network Models and Internet Protocols:** Open Systems Interconnection (OSI) model, TCP/IP model, layered architectures, peer-to-peer processes, encapsulation; addressing: physical addresses, logical addresses, port addresses, specific addresses; IPv4: class, address, mask, gateway, subnetting, super-netting; internetworking devices: hub, switch, router; Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT); comparison between IPv4 and IPv6, IPv6 address format.

**Module III**

**Client Server Interaction:** Uniform Resource Locator (URL), Secure Shell (SSH), Post Office Protocol (POP), Internet Message Access Protocol (IMAP); Application layer protocol: Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Domain Name System (DNS), Simple Mail Transfer Protocol (SMTP), Telnet, Dynamic Host Configuration Protocol (DHCP); Transport Layer Protocol: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP); Internetwork layer protocol: Internet Protocol (IP); Transport layer port numbers.

**Module IV**

**Bandwidth Utilization:** Multiplexing and spreading, multiplexing, spread spectrum, transmission media, guided media, unguided media: wireless, switching, circuit-switched networks, datagram networks, virtual-circuit networks, structure of a switch, using telephone and cable networks for data transmission, telephone networks, dial-up modems, Digital Subscriber Line (DSL), Cable TV networks, Cable TV for data transfer

**Module V**

**Error Detection and Correction:** Introduction, block coding, liner block codes, cyclic codes, checksum, data link control, framing, flow and error control, protocols, noiseless channels, HDLC, Point-to-Point protocol, multiple access, random access, aloha, controlled access, channelization, IEEE Standards, standard ethernet, changes in the standard, fast ethernet, Gigabit ethernet, IEEE 802.11, Bluetooth

**Module VI**

**Connecting LANs:** Backbone networks, and virtual LANs, connecting devices, backbone networks, virtual LANs, cellular telephony, satellite networks, Sonet/SDH, Architecture, Sonet layers, Sonet frames, STS multiplexing, Sonet networks, Virtual tributaries, Virtual-Circuit networks: Frame relay and ATM, Frame relay, ATM, ATM LANs

**Course outcome:**

After Completion of the course the student shall be able to:

- Describe the layers of OSI model, TCP/IP model associated with data communication and able to define its functions.
- Design different types of network topology associated with IPv4.
- Analyze IPv4 and IPv6 addresses, Routing at network layer.
- Illustrate transport layer protocols and DNS protocols.
- Apply Ethernet based wired & different wireless standards and different techniques for connecting networking devices for LANs, Virtual Networks & backbone networks.

- Design and implement error correction and detection codes for correct transmission of data.
- Apply data communication concepts in practical areas.

**Text Book:**

1. Data Communications and Networking, Behrouz A Forouzan, Fourth Edition. TMH.
2. Computer Networks, A. S. Tanenbaum, 4th edition, Pearson education.

**Reference Book:**

1. Introduction to Data Communications and Networking, Wayne Tomasi, Pearson Education.
2. Computer Communications and Networking Technologies, Gallow, Second Edition Thomson
3. Computer Networking and Internet, Fred Halsll, Lingana Gouda Kulkarni, Pearson Education
4. Data and Computer Communications, William Stallings, Pearson Education India.

## Hons. Elective III (seventh semesters)

| EC-4003 | CAD for VLSI | L-T-P-C:3-1-0-4 |
|---|---|---|

**Course objective:** In this course the students will learn VLSI CAD tools and its related concepts, algorithms, Design automation of FPGA and high level synthesis.

**Course content:**

**Unit-I**

Introduction: VLSI design flow, challenges. Verilog/VHDL: introduction and use in synthesis, modeling combinational and sequential logic, writing test benches.

**Unit-II**

Logic synthesis: two-level and multilevel gate-level optimization tools, state assignment of finite state machines. Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding. Technology mapping.

**Unit-III**

Synthesis of reversible logic circuits. Basic concepts of reversible circuits and synthesis. Exact, transformation based, and ESOP based synthesis methods.

**Unit-IV**

Physical design automation. Review of MOS/CMOS fabrication technology. VLSI design styles: full-custom, standard-cell, gate-array and FPGA. Physical design automation algorithms: floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs.

**Course outcome:**

After studying this course, students will be able to:

- understand VLSI Design Automation.
- acquire knowledge about CAD tools used for VLSI design.
- able to understand the Algorithms for VLSI Design Automation.
- use highlevel synthesis.

**Text Book:**

1. Pucknell, Douglas A. and Eshraghian, Kamran, "Basic VLSI Design", Prentice – Hall (India).
2. S.M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits-Analysis & Design", McGraw-Hill.
3. J. Bhasker, "Verilog VHDL synthesis: a practical primer", B S Publications, 1998.

**Reference Book:**

1. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley Pub. Co., 1997.
2. S. Ramachandran, "Digital VLSI systems design", Springer, 2007.
3. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, "High-level synthesis: introduction to chip and system design", Kluwer Academic Publishers, 1992.
4. N.A. Sherwani, "Algorithms for VLSI physical design automation", Kluwer Academic Publishers, 1999.

| EC-4005 | Wireless Sensors Networks | L-T-P-C:3-1-0-4 |
|---|---|---|

**Course objective:**

- To understand the fundamental concept of wireless sensor network protocol.
- To deliberate importance of wireless communication protocols. To explain challenges in routing protocol and overview of different layer protocols.
- To aware with current applications of wireless sensor network in difference field.

**Course content:**

**Unit-I**

Introduction: Basic concept of Wireless Sensor Networks – History, Motivation, Design Objectives, Characteristics, Challenges, Applications, Technological Background – Transmission Fundamental, Actuator, MEMS Technology, Wireless Sensor: Topology, Sensor Network Architectures and Protocol Stack, Network Standards.

**Unit-II**

Medium Access Control: Fundamentals of MAC protocols, Objectives of MAC design, Energy efficiency in MAC design, MAC protocols for wireless sensor networks – Contention based protocols, Contention free protocols, Hybrid protocols. WSN protocols: synchronized, duty cycled.

**Unit-III**

Network and Transport Layer: Overview, Fundamentals and Challenges of Routing protocol, Issues with the adoption of ad hoc Location-aided protocols, Layered and In-network processing-based protocols, Data centric and multipath Protocols. Traditional transport protocols, Traditional Transport protocols for sensor networks: Principles, Performance Metrics, Congestion Control, Reliability, Loss Recovery, Design Guidelines, Case study- Implementation and analysis of Routing protocol or transport layer protocol in Tiny OS.

**Unit-IV**

Network Security and Attack Défense: Fundamentals of network security-challenges and attacks - Protocols and mechanisms for security. Confidentiality, Integrity, Authenticity, Nonrepudiation, Freshness, Availability, Intrusion Detection, Key Management Case study- Handling attacks in Tiny OS.

**Unit-V**

Applications Of WSN**:** WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications

- Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

**Course outcome:**

After completion of course students can be able to:

- To understand technological background of sensor networks.
- To design and apply various existing routing protocols of sensor networks.

**Text Book:**


1. Jun Zheng, Abbas, "Wireless sensor networks A networking perspective", WILEY, 2009.
2. Kazem Sohraby, Daniel Minoli, &Taieb Znati, "Wireless Sensor Networks-Technology, Protocols, And Applications", John Wiley, 2007.


**Reference Book:**


1. Thomas Haensel Mann, "Wireless Sensor Networks: Design Principles for Scattered Systems", Oldenbourg Verlag, 2011.
2. E. H. Callaway, E. H. Callaway, "Wireless Sensor Networks Architecture and Protocols", CRC Press, 2009.
3. F. Zhao and L. Guibas, "Wireless Sensor Network: Information Processing Approach", Elsevier, 2009.
4. A. Hac, "Wireless Sensor Network Designs", John Wiley & Sons, 2009.


| EC-4007 | Adaptive Signal Processing | L-T-P-C:3-1-0-4 |
|---|---|---|

**Course objective:** To provide rigorous foundations in multirate signal processing, power spectrum estimation and adaptive filters.

**Unit-I**

Adaptive systems: Definitions, characteristics, applications, properties, and examples. Linear optimum filtering and adaptive filtering, linear filter structures, adaptive equalization, noise cancellation and beam forming. Optimum linear combiner and Wiener-Hopf equations, orthogonality principle, minimum mean square error and error performance surface.

**Unit-II**

LMS algorithm and its applications, learning characteristics and convergence behaviour, misadjustment. Normalized LMS and affine projection adaptive filters. Frequency domain block LMS algorithm.

**Unit-III**

Least squares estimation problem and normal equations, projection operator, exponentially weighted RLS algorithm, convergence properties of RLS algorithm. Kalman filter as the basis for RLS filter. Square-root adaptive filtering and QR- RLS algorithm. Systolic-array implementation of QR –RLS algorithm.

**Unit-IV**

Forward and backward linear prediction. Levinson-Durbin algorithm, Lattice predictors, gradient-adaptive lattice filtering, least-squares lattice predictor, QR-decomposition based least-squares lattice filters.

**Unit-V**

Adaptive coding of speech, Adaptive equalization of wireless channels, Antenna array processing.

**Course Outcome:** Students will become familiar with the concepts, algorithms and applications of adaptive signal processing in wireless communication systems.

**Text Book:**

1. Simon Haykin., "Adaptive Filter Theory", Pearson Education, 4th Edition, 2002.
2. Widrow, B. and Stearns, S.D., "Adaptive Signal Processing", Pearson Education, 1st Edition, 2002.

**Reference Book:**

1. Sayed Ali, H., "Fundamentals of Adaptive Filtering", John Wiley & Sons, 2003
2. Diniz, P.S.R., "Adaptive Filtering: Algorithms and Practical Implementation", Kluwer Academic Publishers, Boston, MA, 2nd Edition, 2002.

| EC-4009 | Robotics | L-T-P-C:3-1-0-4 |
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**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, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of 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, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning. 2009.