NATIONAL UNIVERSITY

Fourth Year Eighth Semester Syllabus

Department of Computer Science and Engineering

Four Year B.Sc. Honours Course

National University

Subject: Computer Science and Engineering
Syllabus for Four Year B.Sc. Honours Course
Year wise courses and marks distribution

FOURTH YEAR EIGHTH SEMESTER

Course Code	Course Title	Credit Hours
	Major Theory Courses	
540219	Network and Information Security	3.0
540220	Network and Information Security Lab	1.5
540221	Information System Management	3.0
	Project/Industry Attachment	
540222	Project/Industry Attachment	6.0
	Optional Course (any one)	3.0
540223	Simulation and Modeling	
540225	Parallel and Distributed Systems	
540227	Digital Signal Processing	
540229	Digital Image Processing	
540231	Multimedia	
540233	Pattern Recognition	
540235	Design and Analysis of VLSI Systems	
540237	Micro-controller and Embedded System	
540239	Cyber Law and Computer Forensic	
540241	Natural Language Processing	
540243	System Analysis and Design	
540245	Optical Fiber Communication	
540247	Human Computer Interaction	
540249	Graph Theory	
	Optional Course Lab (Any one)	1.5
540224	Simulation and Modeling Lab	

540226	Parallel and Distributed Systems Lab	
540228	Digital Signal Processing Lab	
540230	Digital Image Processing Lab	
540232	Multimedia Lab	
245034	Pattern Recognition Lab	
540236	Design and Testing of VLSI Systems Lab	
540238	Micro-controller and Embedded System Lab	
540240	Cyber Law and Computer Forensics Lab	
540242	Natural Language Processing Lab	
540244	System Analysis and Design Lab	
540246	Optical Fiber Communication Lab	
540248	Human Computer Interaction Lab	
540250	Graph Theory Lab	
	Total Credits in 8th Semester	**18.0**

Course Code : 540219	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Network and Information Security		

Fundamentals on information system security; **Remote access technologies and vulnerabilities**; **accessibility**; security for communication protocols; security for operating systems and mobile programs; security for electronic commerce, passwords and offline attacks; AAA, cryptography; network security applications: authentication, e-mail, IP and web; system security: intruders, malicious software and firewalls; PKI, smart cards, secure multipurpose internet mail extensions; security models; wireless security, sandboxing, router security strategies; security standards: data encryption standard (DES), RSA, digital signature algorithm (DSA), SHA, secure sockets layer(SSL), CBC, IPSec, AES and SET; denial of service (DOS) and distributed DOS attacks; steganography; implementing VPN; Security policy and management; network security assessment.

Reference Books:

1. William Stallings, *Network Security Essentials Applications and Standards*, published by Prentice Hall, 5th Edition.
2. Eric Cole, *Network Security Bible*, published by Wiley.

Course Code : 540220	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Network and Information Security Lab		

(As per theory course)

Course Code : 540221	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Information System Management		

Information systems management: importance of information systems (IS) management, key trends that impacts IS Management, changes in organizational environment, changes in technology environments, IS organizational models, IS management's leadership role, New Roles of IT, Cox Model for IT management, Roger Woolfe's Federal Model for outsourcing, CIO roles in leading, governing, investing and managing, strategic uses of IT in B2E, B2C, B2B, G2P, IS planning, IS planning paradox, differences between strategic, tactical and operational planning, today's sense and response strategy, different planning techniques including stages of growth, critical success factors, competitive forces model, value chain analysis, internet value matrix, linkage analysis planning and scenario planning;

Managing essential technologies: attributes of distributed systems, different types of distributed systems including host-based hierarchy, decentralized standalone systems, peer-to-peer system, hybrid

enterprise wide systems, client-server systems, internet based computing and web services, Four levels of IT infrastructure, managing telecommunications, changes of infrastructure in telecommunications, transformation of telecommunication industries, wireless technology, managing information resources, managing data, giving shape to corporate data, enterprise resource planning, managing information resources, types of information, data warehouses, document management, content management, managing operations, outsourcing IS functions, information security, business continuity planning;

Managing system development: foundation of system development, structured development, fourth generation language, software prototyping, computer-aided software engineering, object oriented development, ERP systems integration, middleware inter-organizational system development, project management, key issues of IS system management, designing motivational works, rethinking maintenance works, improving legacy systems, measuring benefits of IS system as investment;

Systems for supporting knowledge work: supporting decision-making, decision support systems, data mining, executive information systems, expert systems, real customer relationship management, real-time enterprise management, managing different types collaboration, groupware, virtual workforce, virtual organizations, knowledge management, intellectual capital issues, computer ethics and legal jurisdiction, information privacy, online contracting;

Acquisition of hardware, software, networks, and services: request for proposal, acquisition methods (buy, rent, or lease) of software acquisition and analysis of alternatives among in-house development, outsourcing, purchasing and renting;

People and technology: new work environment, organizing principles including self-organizing rather than designed, processes rather than functions, communities rather than groups, virtual rather than physical, learning organization, Internet mindset, value of role of networks, rules of networks, understanding users, executives understanding of IT, Technology camel.

Reference Books:

1. *Information Systems Management in Practice,* 8th Edition, B McNurlin, R Sprague and T Bui.

Course Code : 540222	**Marks : 200**	**Credits : 6**	**Class Hours :--**
Course Title :	**Project/Industry Attachment**		

Course Code : 540223	**Marks : 80**	**Credits : 3**	**Class Hours : 45**
Course Title :	**Simulation and Modeling**		

Systems- System environment and System components; **System models and Simulation** - types of System model and simulation – Discrete and Continues, Static and Dynamic, Deterministic and Stochastic; **Discrete Event driven simulation** – Components and Organization, Event Scheduling/ Time Advance approach and Process Interaction approach,

Event lists and List processing. Basics of Parallel and Distributed Simulation; **Simulation Languages and Packages** – **Process approach to simulation**, application oriented and general purpose simulation language and software: GPSS, SSF API for JAVA and C++, Arena, Extend, SIMUL8 etc. **Probability and Statistical concepts in simulation** – Random variable and its probability distributions, Stochastic process – e.g. Poisson process, Non stationary Poisson process, Compound Poisson process and their properties. Basics of Estimation, Hypothesis tests: Confidence Intervals and t-distribution. **Queuing Models** – Queuing Systems, Queuing behavior (e.g. balk, renege and jockey) and Queuing disciplines, Arrival process, Interarrival time distributions and Service time distributions. Long run measures of performance, Little's formula, Analysis of different Single-server and Multi-Server queuing systems, Queuing networks and their analysis, Jackson's theorem; **Inverse transformation technique for generating random variables**, other techniques: Acceptance–Rejection, Special properties, Convolution etc. **Random Number generation**: Linear Congruent method, composite generators, Random number streams; Testing for random numbers – frequency test and test for autocorrelation; **Input modeling**: identifying input model with data – Histograms, Q-Q plots, selecting the family of distribution, parameter estimation and Goodness-of-fit tests; selecting input model without data, multivariate and time-series input models, Models of arrival processes. **Verification and Validation of simulation models** – face validity, validation of model assumptions, input-out transformation and input output validation using historical input data. **Output data analysis** – types of simulation with respect to output analysis, stochastic nature of output data, measure of performance and their estimators, output analysis for terminating the simulation and for steady state simulations. Techniques for comparison of alternative system design through simulation. **Simulation and queuing models of computer systems**: CPU, memory simulation; Traffic modeling and simulation of computer networks and network protocols, using queuing network analysis.

Reference Books:

1. *System Simulation* by Geoffery Grodon, Prentice Hall
2. *Discrete-event System Simulation* by Banks J and Carson JS, Prentice Hall.
3. *Simulation Modeling with Pascal*, Prentice Hall.
4. *System Simulation with Digital Computer*, Narsing Deo.

Course Code : : 540224	**Marks : 40**	**Credits : 1.5**	**Class Hours : --**
Course Title :	**Simulation and Modeling Lab**		

(As per theory course)

Course Code : 540225	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Parallel and Distributed Systems		

Parallel Processing: Parallel Computer Models: The state of computing, Multiprocessors and Multicomputers, Multivector and SIMD Computers, PRAM and VLSI Models; Program and Network Properties: Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architecture; Processors and Memory Hierarchy: Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

Distributed Systems : Fundamentals**:** Definitions of Distributed Computing Systems, Evolution of Distributed Computing System, Distributed Computing System Models, Why are Distributed Computing Systems Gaining Popularity, Definition of Distributed Operating System, Issues in Designing a Distributed Operating System; Synchronization: Introduction, Clock Synchronization , Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms; Remote Procedure Calls: Introduction, The RPC Model, Transparency of RPC, Implementing RPC Mechanism; Distributed File System: Introduction, Features of Distributed File System, File Services Interface, Directory Server Interface, Semantics of File Sharing, File Systems Implementation, Caching, Stateful File Server, Stateless File server, NFS Architecture; Fault

Tolerance: Component Faults, System Failures, Use of Redundancy, Fault Tolerance Using Active Replication, Fault Tolerance Using Primary Backup;

Reference Books:

1. Advanced Computer Architecture- Kai Hwang
2. Distributed Operating Systems, Concepts and Design- P.K. Sinha
3. Distributed Operating System- Andrew S. Tanenbaum

Course Code : : 540226	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Parallel and Distributed Systems Lab		

(As per theory course)

Course Code : 540227	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Digital Signal Processing		

Introduction to Digital Signal Processing (DSP): Introduction; Digital Signal Processing; Sampling and Analog-to-Digital Conversion; Discrete Time Signals; Ambiguity in Digital signals; Discrete Time Systems; Application areas for DSP; Keys of DSP operations: Convolution, Correlation, Digital Filtering, Discrete Transformation, Modulation; System Design: Methodology & Implementation Methodology.

Discrete Fourier transform: Fourier series, one dimensional Fourier transforms, discrete Fourier Transform (DFT) and its properties, Fast Fourier Transform (FFT) and its algorithm, Inverse discrete Fourier transformation.

The Z-Transform : Introduction to z-Transform; General Results of z-transform; Inverse zTransform: Partial Fraction Expansion, Power Series Expansion, Contour Integration; Comparison of inverse z-transform method; Properties of z-transform; Complex Convolution Theorem and Parseval's Relation.

Implementation of Discrete-Time Systems: Introduction; Block Diagram and Signal Flow Graph Representation of Digital Networks; Matrix Representation of Digital Networks; Basic Structures of IIR Systems: Direct Form, Cascade forms, Parallel Form; Transposed Forms; Basic Structures of FIR Systems; Finite Precision Effects.

Design of Digital Filters: Introduction to Digital Filters; Types of Digital Filters: FIR and IIR; Choosing between FIR and IIR Filters: Digital Filter Design Steps; Design of FIR Filters: Design of FIR Filters by Windowing, Design of Optimum Equiripple Linear-Phase FIR Filters, Design of IIR Filters: Classical Continuous-Time Low-Pass Filter Approximations, Conversion of Transfer Functions from Continuous to Discrete Time, Frequency Transformations of Low pass Filters, Adaptive digital filters: concepts of adaptive filtering, basic wiener filter theory, the basic LMS adaptive algorithm, recursive least square algorithm.

Reference Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, *Digital Signal Processing.*
2. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing – Principles, Algorithms and Applications.*
3. Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, *Discrete-Time Signal Processing.*

Course Code : : 540228	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Digital Signal Processing Lab		

(As per theory course)

Course Code : 540229	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Digital Image Processing		

Introduction to image processing: Representation of image, A basic image processing system, Relationship to human visual system, Example of fields that use digital image processing,

Digital Image Fundamentals: Image formation in the eye, Light and electromagnetic spectrum, Image sensing and acquisition, Image sampling, Image quantization, Some basic relationships between pixels Neighbors of a pixel, Adjacency, connectivity, region, Boundaries, Distance measures

Image enhancement: Some basic gray level transformations, Histogram processing, Histogram equalization, Histogram matching, Image negatives, log transformation, Power law transformation, Basics of spatial filtering, Smoothing spatial filters, Homomorphic filtering, Correspondence between the spatial and frequency domain filtering.

Image Restoration: A model of the image degradation/ Restoration process, Noise models, Restoration in the presence of noise only spatial filtering.

Color Image processing: Color fundamentals, Color models, the RGB color model The CMY, CMYK color Model, HIS color Model, Basics of full-color transformation, Color transformations, formulation.

Image Compression: Image compression fundamentals, Coding redundancy, Inter pixel redundancy

Psychovisual redundancy, Image compression models, The source encoder and decoder, The channel encoder and decoder.

Image Segmentation: Edge detection, line detection, point detection, Boundary Detection, Thresholding, Region based segmentation.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing.*
2. Anil K. Jain, *Fundamentals of Digital Image Processing.*
3. M A Sid-Ahmed, *Image Processing Theory, Algorithms and Architectures.*

Course Code : 540230	Marks : 40	Credits : 1.5	Class Hours : --

Course Title :	Digital Image Processing Lab

(As per theory course)

Course Code : 540231	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Multimedia		

Introduction to Multimedia**:** Design Concepts, Preproduction and Presentation Graphics: Presentation Graphics Design, Preproduction, Typefaces and Graphics. Desktop Publishing, Production Planning and Design, User Interface Design, Hypermedia Authoring Concepts, Multimedia Sound, File Compression**,** Video Production, Digital Video, Animation, HTML & Web-Based Multimedia, Designing Web-based Multimedia, Producing Multimedia**,** Content & Legal Considerations for Multimedia, Content & Legal Considerations for Multimedia, Multimedia Distribution, Networking Multimedia.

Reference Books:

1. Olu Lafe,"*Cellular Automata Transforms: Theory and Applications in Multimedia Compression, Encryption, and Modeling*", Kluwer Academic Publishers, 1st edition, 2000.
2. Barry G. Haskell, Atul Puri, Arun N. Netravali,"*Digital Video : An introduction to MPEG-2 (Digital Multimedia Standards Series)*", Springer, 1st edition, 1996.

Course Code : 540232	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Multimedia Lab		

(As per theory course)

Course Code : 540233	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Pattern Recognition		

Introduction to Pattern Recognition: Classification Statistical Methods, Structural Methods and Hybrid method. Introduction to passen grammar and languages. Applications to character recognition medical

imaging area. feature detection, classification, Review of probability and some linear algebra. Bayesian Decision Making, linear discriminants, separability, multi-class discrimination; quadratic classifiers, Fisher discriminant, sufficient statistics, coping with missing or noisy features, Bayesian estimation; non-parametric estimation; Non-parametric classification, density estimation, Parzen estimation, training methods, maximum likelihood, Bayesian parameter estimation, MAP. Linear discriminant functions.. Template-based recognition, eigenvector analysis, feature extraction, Eigen vector analysis. Clustering, unsupervised learning, vector quantization, K-means and E/M, neural nets. Sequence analysis, HMMs. k-nearest-neighbor classification, Mixture modeling, Optimization by Expectation, Maximization, Hidden Markov models, Viterbi algorithm, Baum-Welch algorithm, Linear dynamical systems, Kalman filtering and smoothing, Bayesian networks, independence diagrams, Decision trees, Multi-layer Perceptrons.

Reference Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork,"*Pattern Classification*", Wiley- Interscience, 2nd edition, 2000.

Course Code : 540234	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Pattern Recognition Lab		

(As per theory course)

Course Code : 540235	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Design and Analysis of VLSI Systems		

Introduction to MOS technology: POMS, NMOS and CMOS, transistors, CMOS Fabrication **Design Approaches:** Fabrication steps, steps stick diagrams, design rules and layout, contact cuts, double metal MOS process rules. MOS circuits, **Delay Analysis**: Inverter delay and its analysis, delay of different sequential and combinational circuit. **Sequential System:** Super buffer, Dynamic MOS circuits, Scaling of MOS circuits. Scaling factors and device parameters. **Subsystem design and layout**. **Switch logic**: pass transistors and transmission gates. Gate logic: The inverter, Two input nMOS, CMOS and BiCMOS gate design. Design of parity generator and multiplexers. Registers, Counters and memory realizations, One transistor and three transistors dynamic RAM cell design. **Hierarchical view of VLSI System Design**: Behavioral description High level Synthesis Scheduling, allocation and data path synthesis. **Logic synthesis**: multilevel minimization, PLA reduction regular structure circuits, Synthesis of FSM-ASM chart representation and realization, Layout synthesis, Placement and routing, Testing of VLSI, Testing of stuck-at fault, Testing of PLAs RAM. **Introduction to Reversible Logic:** Theory of reversibility, Reversible gates, reversible circuits, reversible logic synthesis. **FPGA:** Introduction to FPGA and FPGA programming using VHDL.

Reference Books:

1. *Basic VLSI Design System and Circuits*, Douglas A. Pucknell, KAMRAN Eshraghiam, Prentice Hall International Inc. Second Edition.
2. *Modern VLSI Design* by Wayne Wolf.

Course Code : 540236	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Design and Testing of VLSI Systems Lab		

(As per theory course)

Course Code : 540237	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Microcontroller and Embedded System		

Introduction to the Embedded Systems, Embedded System Design Specifications, Embedded System Hardware and Hardware/Software Co-design, 8051/8052 family of Microcontrollers, C programming for Microcontrollers, I/O ports Programming, Timer/Counter hardware and Its Device Driver, Serial communication interface and Its Device Driver, Interrupts Programming, Embedded Software Development Cycle and the Integrated Development Environment, Debugging Techniques for Embedded Software and the Role of Cross Simulators, Real World Interfacing Case Studies: LCD, Sensors, stepper motor, keyboard, PC, Design of Device Driver for Serial Devices, Concept of Finite State Machines and Examples - Stop Watch, Stepper Motor Control through PC, Remote Control of Systems using IR Remotes Used in Commercial TV Remote Control Modules, Simple Multi Drop Communication Networks With Examples, Simple Wireless Communication With Examples.

Reference Books:

1. *Introduction to Embedded Systems Using Microcontrollers and the MSP430* : Jiménez, Manuel, Palomera, Rogelio, Couvertier, Isidoro
2. *The 8051 Microcontrollers and Embedded Systems* : Muhammed Ali Mazidi
3. *The 8051 Microcontrollers Architecture, Programming & Applications* : Kenneth J. Ayala

Course Code : 540238	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Micro-controller and Embedded System Lab		

(As per theory course)

Course Code : 540239	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Cyber Law and Computer Forensic		

Overview of Cybercrime: Samples of cybercrime, Unique Characteristics of Cybercrime, Cyberattacks and attackers. Cybercrime Law. Computer Intrusions and Attacks: computer trespass, unauthorized access, relationship between acceptable use policies ("AUP"), terms of service ("TOS"), and criminal law. Hacking: Hacking for Grades, Hacking for harrassment ("swatting"), URL hacking, WiFi Mooching. Computer Viruses, Time Bombs, Trojans, Malicious Code, malware, Spam, Botnets, Logic Bomb, Rootkits. Online Fraud and Identity Theft: Intellectual Property Theft; Virtual Crime. Online Vice: Gambling; Pornography; Child Exploitation. International Aspects and Jurisdiction, Infrastructure and Information Security; Risk Management, Investigating Cybercrime: Interception: Search and Seizure, and Surveillance. Information Warfare: Cyberterrorism and Hacktivism. Terrorism, Radicalization, and the War of Ideas. Trade Secret Theft and Economic Espionage. National Security. Computer Forensic: overview of the forensic relevance of encryption, the examination of digital evidence for clues, and the most effective way to present evidence and conclusions in a court of law.

Reference Books:

1. *Computer Forensics and Cyber Crime*: An Introduction, 3rd Edition, Marjie T. Britz 2. *Digital Evidence and Computer Crime*, 3rd Edition, Eoghan Casey

Course Code : 540240	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Cyber Law and Computer Forensics Lab		

(As per theory course)

Course Code : 540241	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Natural Language Processing		

Words, Parts of Speech, Syntax, Grammars, Semantics, Language Modeling in General and the Noisy Channel Model., Linguistics: Phonology and Morphology Word Classes and

Lexicography. Mutual Information. The t-score. The Chi-square test. Hidden Markov Models (HMMs). The Trellis & the Viterbi Algorithms. HMM Tagging (Supervised, Unsupervised). Evaluation methodology (examples from tagging). Precision, Recall, Accuracy. Statistical Transformation Rule-Based Tagging. Maximum Entropy Tagging. Feature Based Tagging. Results on Tagging Various Natural Languages. Non-statistical Parsing Algorithms (An Overview). Simple top-down parser with backtracking. Probabilistic Parsing. Introduction.

Statistical Machine Translation (MT).

Reference Books:

1. Daniel Jurafsky, James H. Martin,"*Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*", Prentice Hall, 1st Edition, 2000.

2. Christopher D. Manning, Hinrich Schtze,"*Foundations of Statistical Natural Language Processing*", The MIT Press; 1st edition, 1999.

Course Code : 540242	**Marks : 40**	**Credits : 1.5**	**Class Hours : --**
Course Title :	**Natural Language Processing Lab**		

(As per theory course)

Course Code : 540243	**Marks : 80**	**Credits : 3**	**Class Hours : 45**
Course Title :	**System Analysis and Design**		

Introduction to general systems theory, Players in the Systems Game, Information Systems Building Blocks. Information Systems Development, Project Management. Systems Analysis, Requirements Discovery, Deliverables, Data Modeling and Analysis, Process Modeling, Feasibility Analysis and System Proposal, Systems Design, Applications Architecture and Modeling, Database Design, Output Design and Prototyping, Input Design and Prototyping, User Interface Design, Systems Construction and Implementation, Systems Operations and Support, Object-Oriented Analysis and Modeling, Object-Oriented Design and Modeling.

Reference Books:

1. *Modern Systems Analysis and Design*, Jefrey A. Hoffer, Pearson Education Asia.
2. *Systems Analysis and Design*, Shin Yen Wu, West Publishing Company.

Course Code : 540244	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	System Analysis and Design Lab		

(As per theory course)

Course Code : 540245	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Optical Fiber Communication		

History of optical communication, advantages and limitations of fiber communication. Theory of light: reflection, refraction, critical incident angle, total internal reflection. Electromagnetic waves, Maxwell's equation, damping waves, wavefront, propagation constant, phase velocity, group velocity. Basics of optical fiber: acceptance angle, numerical aperture, fiber structure, comparison with copper, meridional rays, skew rays, v number of a fiber, modes in a planar guide, Evanescent field, single mode fiber, multimode fibers. Fabrication of optical fibers: Vapor phase deposition techniques: OVD, MCVD, PCVD, VAD, coating. Optical sources: requirements , energy band diagram, LED: (principle of action, internal quantum efficiency, homostructure and heterostructure of LEDs), Laser: (principle of action, properties of stimulated radiation, positive feedback, population inversion, lasing effect, properties of laser beam, types of lasers: QW, Fabry-Perot, DFB, VCSEL), Superluminescent diodes (SLD), blocks of optical transmitter. Photo detectors: principle of action, responsivity, quantum efficiency, modes of operation, advantages of reverse biasing, sensitivity, efficiency of light-current conversion, p-i-n photodiodes: (features, types, advantages), avalanche photodiode: working principle, noise sources in photodiode, blocks of receiver. Losses in fiber: Material absorption loss, Linear scattering loss, Nonlinear scattering loss, Fiber bend loss, Coupling loss, Dispersion, Polarization loss. Fiber optic cables, optical connectors: (basic structure, preparation, types, characteristics), fiber splices: (splicing procedure, mechanical splice, fusion splice, PAS, PAT). Optical network: OTDM, WDM and DWDM: (lasers, transmitter requirements, receiver requirements, add/drop problem, repeaters), Tunable lasers: (characteristics, external cavity, DBR, integrated cavity lasers). Optical amplifiers: advantages, types, SOA: (types: FPA and TWA, principle of operation, advantages, and disadvantages). EDFA: (principle of operation, characteristics, structure, advantages, noise, DBFA, EBFA). Optical switches, Wavelength converters, Couplers/splitters, WDM mux and demux, filters, Isolators, Circulators, Attenuators. Optical layer: sections, sublayers, services. Protection and restoration techniques.

Reference Books:

1. *Fiber-Optic Communications Systems*, Third Edition. Govind P. Agrawal, John Wiley & Sons, Inc.
2. *Optical Fiber Communications*, Fourth Edition, Gerd Keiser, Tata McGraw Hill.

Course Code : 540246	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Optical Fiber Communication Lab		

(As per theory course)

Course Code : 540247	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Human Computer Interaction		

Foundations of Human Computer Interaction: Humans and Machines, Interaction, Collaboration. Models in HCI: Cognitive Models, Socio-organizational Issues and Stakeholder Requirements. Importance of cognitive abilities. Design Process: Interaction Design Basics, HCI in Software Process, Design Rules, Universal Design, User Center Design. Design. Prototyping, Task Analysis, GOMS and other key HCI methods. Lifecycle Models. User Interfaces: Interfaces Basics, Interaction Techniques, System Control of Interfaces, Human Factors and Strategies in Designing Interfaces. Evaluation and User Support: Evaluation, Evaluation of Interfaces, User Support. Tasks Models and Dialogs: Analysing the Task, Dialog Notations and Design. Groupware, Ubiquitous Computing, Virtual and Augmented Reality. Social-Cultural Contexts of HCI.

Reference Books:

1. Andy Downton,"*Engineering the Human-Computer Interface(Essex Series in Telecommunications and Information Systems)*", McGraw Hill, 1993.

Course Code : 540248	Marks : 40	Credits : 1.5	Class Hours : --
Course Title :	Human Computer Interaction Lab		

(As per theory course)

Course Code : 540249	Marks : 80	Credits : 3	Class Hours : 45
Course Title :	Graph Theory		

Fundamental concepts, varieties of graphs, path, cycles and components, degrees and distances, clique. Trees: Properties, spanning trees, forests, centroids, generation of trees and cycles, ent cycles and co-cycles. Connectivity: Vertex and edge connectivity, blocks, eccentricity, Menge's Theorem. Traversability: Eulerian graphs, kuratowski's theorem, embedding graphs on surfaces, genus, thickness and crossing number. Graph Coloring: Vertex coloring, edge coloring, chromatic number, five color theorem, four

color conjecture, critical graph. Homomorphism Digraph: Different connectedness, oriented graphs-tournaments, network flows and related algorithms. Groups, polynomials and graph enumeration, matching and factorization, perfect graphs, Ramsey number and Ramsey theorem, forbidden graph theory, miscellaneous applications.

Reference Books:

1. V.K. Balakrishnan,"*Schaum's Outline of Graphs Theory: Including Hundreds of Solved Problems*", Schaum's.
2. Douglas B. West,"*Introduction to Graph Theory*", Prentice Hall, 2nd edition, 2000.

Course Code : 540250	**Marks : 40**	**Credits : 1.5**	**Class Hours : --**
Course Title :	**Graph Theory Lab**		

(As per theory course)