SYLLABI
FOR
MASTER OF ENGINEERING
IN
INFORMATION AND COMMUNICATION ENGINEERING (ICE)

OFFERED BY
DEPARTMENT OF INFORMATION TECHNOLOGY

EFFECTIVE FROM
JULY 2007

BENGAL ENGINEERING AND SCIENCE UNIVERSITY,
SHIBPUR, HOWRAH 711 103
WEST BENGAL, INDIA

Course Structure of
Master of Information and Communication Engineering (ICE)

I FIRST SEMESTER (Section A Examination)

(A) Theory Papers

	Weekly Contact Hours	Marks
a) Field Subjects		
1. Paper I : Advanced Comm. Systems (ICE 901)	3	100
2. Paper II : Information Theory & Coding (ICE 902)	3	100
3. Paper III: Design of Database Systems (ICE 903)	3	100
b) Elective Subjects		
4. Paper IV : Elective I (ICE 904/X)	3	100
5. Paper V : Elective II (ICE 905/X)	3	100
(B) Sessional on Subjects		
6. Sessional on Paper I, II, III (ICE 951)	6	90
7. Sessional on Paper IV (ICE 952/X)	2	30
8. Sessional on Paper V (ICE 953/X)	2	30
TOTAL	**25**	**650**

II SECOND SEMESTER (Section B Examination)

(A) Theory Papers

a) Field Subjects		
1. Paper VI : Digital Voice & Picture Processing (ICE 1001)	3	100
2. Paper VII : Internet and Web based Technology (ICE 1002)	3	100
3. Paper VIII : Information & System Security (ICE 1003)	3	100
4. Paper IX : Soft Computing Techniques (ICE 1004)	3	100
b) Elective Subjects		
5. Paper X : Elective III (ICE 1005/X)	3	100
(B) Sessional Subjects :		
6. a) Term Paper and/or project related to thesis/Laboratory (ICE 1051)	6	100
b) Seminar on Term paper and /or Project related to thesis/ Laboratory Sessional (ICE 1052)	-	50
TOTAL	**21**	**650**

III THIRD SEMESTER (Section C Examination)

1. Progress report on Thesis	-	100
2. Seminar and Viva-Voce	-	50
TOTAL		**150**

IV FOURTH SEMESTER

1. Thesis	-	250
2. Viva-Voce	-	100
TOTAL		**350**

Detailed Syllabus

Semester: I

Paper I: Advanced Communication Systems (ICE 901)

Baseband, narrowband and wideband signals and noise representation and characteristics of communication channels.

Baseband binary signal transmission over bandlimited channels, Transmission coding and PSD, ISI and its control.

Synchronization techniques: Carrier, bit and frame synchronization, optimum receive filtering, match filtering.

M-ary signals orthogonal representation, Gram-Schmidt procedure, signal space concept, bandwidth efficient digital carrier modulation techniques: Binary and M-ary shift keying techniques, QPSK, MPSK, MSK, GMSK, coherent and non-coherent detection, PSD and bit error rate calculation.

Spread Spectrum: Concept of spectrum spreading, process gain, properties and generation of code patterns, DSSS, FHSS, THSS techniques and their comparison.

Principle of detection and estimation: Binary and M-ary hypothesis testing. Bayes' likelihood ratio test, waveform estimation, linear estimation problems, Wiener filtering, Kalman filtering.

Paper II: Information and Coding Theory (ICE 902)

Sources-memoryless and Markov; Information; Entropy for discrete ensembles; Shannon's noiseless coding theorem; source coding; Mutual Information; channel capacity; BSC and other channel.

Shannon's noisy coding theorem and converse for discrete channels; Continuous channels; Comparison of communication systems based on Information Theory; Quantum Information.

Channel Coding, linear block codes; cycle codes: Golay codes and cyclic Redundancy Check (CRC) codes; BCH and Reed-Soloman codes; Convolution codes; majority logic decoding; Viterbi decoding algorithm; LDPC codes; Space-time coding for SISO and MIMO systems

Paper III: Design of Database System (ICE903)

Basic concepts, Advantages of Database systems over traditional file processing system. Database System Architecture: Data Abstraction, Data Independence, Data Definition and Data Manipulation Languages.

Data Models: Entity-Relationship, Network, Relational and Object Oriented Data Models, Integrity Constraints, and Data Manipulation Operations.

Relational Query Languages: Relational Algebra, Tuple and Domain Relational Calculus, SQL and QBE.

Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.

Query Processing and Optimization: Evaluation of Relational Algebra Expressions, Query Equivalence, Join strategies, Query Optimization Algorithms.

Storage Strategies: Indices, B-trees, Hashing. Transaction Processing: Recovery and Concurrency Control, Locking and Timestamp based Schedulers, Multiversion and Optimistic Concurrency Control schemes.

Advanced Topics; Object-oriented and Object Relational Databases, Introduction to Distributed Databases, Web Databases, Data Warehouse and Data Mining.

Paper IV and V: Elective I & II

(i) Mathematical Methods for Computing (ICE 904/1)

Vector spaces. Linear dependence of vectors, basis, linear transformations, rank and inverse of a matrix, solution of algebraic equations, consistency conditions. Eigen values and eigenvectors, Hermitian and skew Hermitian matrices.

Finite differences, Newton's forward and backward interpolation formulae, Central difference interpolation. Trapezoidal rule and Simpson's 1/3rd rule of integration. Solution of polynomial and transcendental equations ' bisection method, Newton Raphson method and Regula falsi method.
Sets, relations, and functions *:* Basic operations on sets, cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses. Arbitrary union , intersection and product.
Propositional Logic*:* Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deduction theorem, etc. Decision problems of propositional logic. Introduction to first order logic and first order theory ? set theory, axiom of choice. Size of a set : Finite and infinite sets, countable and uncountables, Cantor's diagonal argument and power set theorem, non-computability of all number theoretic ;functions.
Partially ordered sets : Complete partial ordering, chain, lattice. Complete, distributive, modular, and complemented lattices. Boolean and pseudo boolean lattices. Different sublattices, monoton map and morphaisms, quotient structures, filters. Tarski's fixed points theorem.
Algebraic Structures : Algebraic structures with one binary operation, semigroup, monoid and group. Congruence relation and quotient structures. Morphisms. Free and cyclic monoids and groups. Permutation group. Substructures, normal subgroup. Error correcting code. Algebric structures with two binary operations- ring, integral domain, and field. Boolean algebra and boolean ring.
Introduction to Counting *:* Basic counting techniques. inclusion and exclusion, pigeon-hole principle, permutation, combination, summations. Introduction to recurrence relation and generating function. Introduction to Graph : Graphs and their basic properties ? degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, graph colouring, planar graph, trees.

(ii) Digital Signal Processing (ICE 904/2)

Discrete time signals: Sequence; representation of signals on orthogonal basis; sampling and reconstruction of signals;
Discrete systems: attributes, Z- transforms: Properties, analysis of discrete time systems. The DFT; Definition and properties, circular convolution calculation, FFT and Chirp transform.
Digital filters: definition and properties. FIR filters, IIR filters
Digital filter design techniques: Impulse invariance, Bi-linear transformation, finite difference, window design methods, frequency sampling optimization algorithms. VLSI computing structures for signal processing.
Finite Word Length Effects: Quantization error and their effects on performance of digital signal processors
Multidimensional Signals and Systems: Discrete Fourier analysis of Multidimensional Signals, Design and Implementation of Two Dimensional FIR Filters, IIR Filters
Adaptive Systems: Definition and Characteristics, Adaptive Algorithms and Structures.
Parametric and non-parametric spectral estimation, introduction to multirate signal processing, application of DSP: speech , image, radar, sonar, biomed and communications.

(iii) Software Engineering: (ICE 904/3)

Introduction. Life cycle models, Requirements analysis and specification, Formal requirements specification. Fundamental issues in software design: goodness of design, cohesion, coupling. Function-oriented design: structured analysis and design. Overview of object-oriented concepts. Unified Modelling Language (UML). Unified design process. User interface design. Coding standards and guidelines. Code walkthrough and reviwes. Unit testing. Black box and white box testing. Integration and system testing. Software quality and reliability. SEI CMM and ISO 9001. PSP and Six Sigma. Cleanroom technique. Software project management. Configuration management. Software maintenance issues and techniques. Software reuse. Client-server software development.

(iv) Design of Operating System (ICE 904/4)

Evolution of Operating Systems, Structural overview, Booting of an OS, Interrupts, Context switching, Concept of process and Process synchronization, Process Management and Scheduling, Inter-process communication, Hardware requirements: protection, privileged mode; Threads and their Management; Tools and Constructs for Concurrency, Detection and Prevention of deadlocks, Dynamic Resource

Allocation, Design of IO systems, File Management, Memory Management: paging, virtual memory management, Distributed and Multiprocessor Systems, Case Studies: UNIX/LINUX, WINDOWS NT/2000/XP.

(v) Natural Language Processing (ICE 904/5)

Words: Regular Expressions and Automata, Morphology and Finite-State Transducers, Computational Phonology and Pronunciation Modeling , Probabilistic Models of Pronunciation and Spelling.

Syntax: N-gram Models of Syntax, HMMs and Speech Recognition, Word Classes and Part-of-Speech Tagging, Context-Free Grammars for English Parsing , Context-Free Grammars, Lexical Functional Grammar, Tree Adjoining Grammar Features and Unification, Lexicalized and Probabilistic Parsing, Language and Complexity

Semantics: Representing Meaning, Semantic Analysis, Lexical Semantics, Word Sense Disambiguation and Information Retrieval.

Pragmatics: Discourse, Dialog and Conversational Agents, Natural Language Generation

Multilingual Processing: Machine Translation

(vi) Human Intelligence Enterprise and AI (ICE 904/6)

Development of a computational understanding of human intelligence: object tracking, object recognition, change representation, language evolution, role of symbols in learning and communication

Review of visionary ideas of Turing, Minsky, and other influential thinkers: role of brain scanning, systems neuroscience, and cognitive psychology

Problem solving by search: state space, problem reduction, game playing, constraint satisfaction;

Automated Reasoning: proposition and first order logic, inference and deduction, resolution refutation, answer extraction, knowledge based systems, logic programming and constrained logic programming, non-monotonic reasoning;

Planning: state-space, plan space and partial order planning, planning algorithms;

Reasoning under Uncertainty: probabilistic reasoning, belief networks;

Learning: inductive learning, decision trees, logical approaches, computational learning theory, Neural networks, reinforcement learning; Intelligent Agents; Natural Language Understanding; Applications

(vii) Advanced Computer Networking (ICE 905/1)

Introduction: Overview of computer networks, seven-layer architecture, TCP/IP suite of protocols, etc.

Routing and flow control: Deterministic techniques; Stochastic routing; Adaptive routing; Optimal routing; Congestion control in networks; Global control.

MAC protocols for high-speed LANS, MANs, and wireless LANs: FDDI, DQDB, HIPPI, Gigabit Ethernet, Wireless Ethernet.

Fast access technologies: ADSL, Cable Modem

Basics of IPv4, Classes of IP addresses, IPv6: Why IPv6, basic protcol, extensions and options, support for QoS, security, etc., neighbour discovery, auto-configuration, routing. Changes to other protocols. Application Programming Interface for IPv6. 6bone.

Mobility in networks. Mobile IP. Security related issues.

IP Multicasting. Multicast routing protocols, address assignments, session discovery, etc.

TCP extensions for high-speed networks, transaction-oriented applications. Other new options in TCP.

Network security at various layers. Secure-HTTP, SSL, ESP, Authentication header, Key distribution protocols. Digital signatures, digital certificates.

(viii) Wireless and mobile communication (ICE 905/2)

Radio communication principles, problems in message transmission through wireless channel, propagation modes, LOS transmission, multipath propagation and signal fading in mobile environment.

Radio frequency signal modeling and channel characterization: Rayleigh, Rician, Nakagami, Suzuki and Log-normal distribution.

Receiver techniques for fading dispersive channels: Channel equalization, adaptive equalizing, diversity techniques.

Cellular concept: Frequency assignment, frequency reuse, concept of cell splitting, Handover in cellular systems, soft and hard handoff, handoff algorithms.
Multiple access schemes in mobile communication: TDMA, FDMA, CDMA, GSM architecture, OFDM and multicarrier CDMA. CDMA optimization issues. MAC layer scheduling and connection admission in mobile communication. Interference suppression and power control.
Mobile satellite communications; Cordless systems and Wireless local loop; Mobile IP and Wireless access Protocol; Satellite PCS; WLAN; Bluetooth.

(ix) Data warehousing and data mining (ICE 905/3)

Overview: Data warehousing, OLAP and Data mining, Classification of data mining techniques, Discovery and analysis of patterns, trends, and deviations, Data mining models: decision trees, genetic algorithms, neural nets, etc. Clustering, Enabling data mining through data warehouse. Data marts, Multidimensional databases, Data mining applications.

(x) Advanced Computer Architecture (ICE 905/4)

Overview of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.
Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards Exception handling. Pipeline optimization techniques. Compiler techniques for improving performance. Hierarchical Memory Technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism: basic concepts, techniques for increasing ILP; super scalar, superpipelined and VLIW processor architectures.Array and vector processors. Multiprocessor Architecture: taxonomy of parallel architectures; Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann Architectures: data flow Computers, reduction computer architectures, systolic architectures.

(xi) Image Processing (ICE 905/5)

Human visual system and image perception, monochrome and colour vision models, colour representation; image sampling and quantization.
Image Transforms : Fourier, Hadamard, Walsh, Discrete cosine and Hotelling.
Image Enhancement: Filters in spatial and frequency domains, histogram-based approaches, smoothing, Filtering, homomorphic filtering.
Image Restoration - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods,
Segmentation: pixel classification, Bi-level thresholding, multilevel thresholding, split and merge algorithm, region growing.
Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition.
Image exture analysis: co-occurence matrix, Statistical model based methods.
Image communication: JPEG, MPEG and H.26x standards, packet video, error concealment.
Misc. topics such as-Hough Transform, boundary detection, image analysis using multiresolution techniques.

(xii) Optical Communication (ICE 905/6)

Introduction: Nature of light
Modulation of light: elliptical polarization, birefringence, optical activity, electro-optic effect, Kerr modulators, scanning and switching, magneto-optic devices, acousto-optic effect, non-linear optics
Optical Communication Systems: Introduction, System description
Optical Fibers: types, light propagation, configurations, classifications, losses; Characteristic equation of step-index fiber, modes and their cut-off frequencies, Graded-index fibers - WKB and other analysis, propagation constant

Optical sources: LED, Homojunction & Heterojunction LED, Surface and Edge emitting LED, ILD
Photodetectors: principles of operation, PIN, APD, MSM
LASER: review of introductory concepts, modes, classes, single mode operation, frequency stabilization, mode locking, Q-switching, applications, measurement of distance
Communication: Intensity modulation and direct detection (IM/DD); S/N ratio and BER, power penalty; L Wavelength Division Multiplexing - System requirements, MUX/DEMUX devices
Fiber Optic Communication Systems: Operating wavelength, emitter design, detector design, fiber choice, system design considerations, LAN, system link budget.

(xiii) Object oriented Design (ICE 905/7)

Introduction: Abstraction-based design, Object Oriented Programming (OOP):
Classes, Objects, Attributes, Methods, Messages, Abstraction, Encapsulation, Modularity, Inheritance, Inheritance, Exception Handling.
Generalisation / specialization / aggregation: Generalisation-specialisation hierarchy, Supertypes, subtypes Inheritance, Generalisation and Type definition, Sub-type definition and rule, Abstract Types, Aggregation, Composite/Shared Aggregation
Frameworks, Patterns, Persistence: Define patterns, Applying patterns and assigning responsibilities ,Coupling and Cohesion , Applying patterns to assign responsibilities to classes ,Define frameworks Persistence
Iterative development and the Unified Process (UP) : Iterative process in software development and the benefits thereof , Fundamental concepts in the Unified Process (UP), UP phases: Inception, Elaboration, Construction and Transition,UP Disciplines: Business Modelling, Requirements, and Design
OO Life Cycle Models**:** Object Oriented Analysis and Design (OOD) with UML
Class Diagrams:
State Diagrams: Events, states and transitions,Use Case State diagram, State independent and State dependent Classes or Types, External and internal events
Use Cases: Use Cases and functional requirements, Goals and scopes of Use Case, Identifying and types of Actors, Finding Primary Actors, Goals, and Use Cases, Identifying and writing Use Cases, Use Case types and formats, Contrast high level and expanded Use Cases, High Level Use Cases, Expanded Use Cases, Primary, Secondary, Optional Use Cases, Types. Essential and Real Use Cases, Drawing Use Case Diagrams, Ranking Use Cases, Use Cases within the UP
Sequence Diagrams**:** Identify system events and system operations. System Sequence diagrams, System events and system operations, Creating a System Sequence Diagram.
Metrics and Measures for Object Oriented Systems:
Object Oriented Testing: Black-box Testing, White-box Testing, Unit Testing, Integration Testing, Coverage.
Java GUI Framework: Basic Concepts, Using Containers and Layout Managers, Drawing Shapes and Animation
UML and CASE tools: Fitting UML into the Unified Process, Computer Assisted Software Engineering (CASE) tools
Design Class Diagrams (DCD): Identify classes, methods and associations, When to create a DCD, DCDs and the UP, Domain Model and Design Model Classes, Steps for creating DCDs, DCDs and CASE tools, DCDs within the UP
Current Trends in Software Development:
Aspect Oriented Programming, Agile Methods, Extreme Programming, Model-Driven Architecture.

Semester II

Paper VI: Digital voice and picture processing (ICE 1001)

Digital speech communication, characteristics of speech signals, spectral and non-spectral analysis techniques, model-based coding techniques, time domain waveform coding of speech – PCM, DPCM, ADPCM, DM and sub-band coding, frequency domain waveform coding of speech – LTC, ATC; Parameter Coding of Speech-Channel.

Noise reduction and echo cancellation; Synthetic and coded speech quality assessment. Digital Picture Communication; Characteristics of picture signals in time and frequency; Statistical properties of video signals, Subjective and objective quality assessment. Elements of visual perception; Sampling, interpolation and quantization of video signals, Motion Estimation in video signal. Coding of monochrome and color video signals – Transform and Adaptive transform coding.
Digital voice and video compression, introduction to HDTV, Audio and video conference; video telephone.

Paper VII: Internet and Web based Technology (ICE 1002)

Name services and configuration: DNS, DHCP, X500 directory services, LDAP. Internet security. Basics of authentication and encryption, SSL, Digital Signature, Kerberos. Network management: SNMP. CGI scripts, Scripting Languages. Perl, PHP, JavaScript, VBScript. Web Services. XML, SOAP, UDDI, WSDL, Platforms for Web Services Development - .NET, J2EE, E-Commerce - Secure Electronic Transactions over the net.

Paper VIII: Information and System Security (ICE 1003)

Introduction: Overview of security in information communication, IP & web security and media security.
Cryptography: Basic objectives of cryptography, secret-key and public-key cryptography. Block ciphers: Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis.

Public-key parameters: Modular arithmetic, gcd, primality testing.
Public-key encryption: RSA, Rabin and EIGamal schemes, side channel attacks, Key exchange.
IP Security: overview, architecture; authentication header and security payload encapsulation
Web Security: Intrusion detection systems, Expert systems, game theoretic approaches
Media Security: Data hiding, Steganography & Steganalysis, Digital watermarking, Visual cryptography.

Paper IX: Soft Computing Techniques (ICE 1004)

Limitations of Artificial Intelligence; Definition of Soft Computing; Difference between Hard and Soft Computing; Introduction to Fuzzy Systems, Artificial Neural Network, Genetic Algorithm, Rough Set Theory; Hybrid Systems.
Fuzzy Systems: Fuzzy Set Theory, Fuzzy Relation, Fuzzy Logic, Approximate Reasoning, Fuzzy logic Controller, Applications.
ANN: NN Architectures, Learning Methods, The Perceptron Model, Backpropagation Learning, Hopfield NN and Stability Analysis, Associative Memory, Competitive Learning Methods, Adaptive resonance Theory NN; Applications.
GA: Difference between Traditional Algorithms and GA, Encoding, Fitness Function, Reproduction, Cross Over, Mutation, Convergence Theory; Applications.
Rough Set: Indiscernibility Relations, Reducts, Rough Approximation,; Applications.
Hybrid Systems: Neuro Fuzzy Systems, Fuzzy Logic Controlled GA, Fuzzy Membership Interpretation using Rough Set theory etc.

Paper X: Elective III

(i) Mobile Computing: (ICE 1005/1)

Introduction: Challenges in mobile computing, mobile channel characterization, resource poorness, banwidth, etc. review of cellular schemes, mobile computing topologies.
Mobility: handoff, types of handoffs; location management, HLR-VLR scheme, hierarchical scheme, predictive location management schemes. Mobile IP, cellular IP.
Publishing & Accessing Data in Air: Pull and push based data delivery models, data dissemination by broadcast, broadcast disks, directory service in air, energy efficient indexing scheme for push based data delivery.
File System Support for Mobility: Distributed file sharing for mobility support, Coda and other storage manager for mobility support

Ad hoc Network Routing Protocols: Ad hoc network routing protocols, destination sequenced distance vector algorithm, cluster based gateway switch routing, global state routing, fish-eye state routing, dynamic source routing, ad hoc on-demand routing, location aided routing, zonal routing algorithm.

(ii) Embedded System (ICE 1005/2):

Introduction to Embedded Systems - definitions and constraints; hardware and processor requirements; special purpose processors; input-output design and I/O communication protocols; design space exploration for constraint satisfaction; co-design approach; example system design; Formal approach to specification; specification languages; specification refinement and design; design validation; Real Time operating system issues with respect to embedded system applications; time constraints and performance analysis.

(iii) Bioinformatics (ICE 1005/3):

Sequence similarity, homology, and alignment. Pairwise alignment: scoring model, dynamic programming algorithms, heuristic alignment, and pairwise alignment using Hidden Markov Models. Multiple alignment: scoring model, local alignment gapped and ungapped global alignment. Motif finding: motif models, finding occurrence of known sites, discovering new sites. Gene Finding: predicting reading frames, maximal dependence decomposition. Analysis of DNA microarray data using hierarchical clustering, model-based clustering, expectation-maximization clustering, Bayesian model selection.

(iv) Pattern Recognition: (ICE 1005/4):

Introduction and overview of different approaches to PR, dimensionality reduction, regression techniques, Principal Component Analysis; Feature extraction and selection, Classification: linear and non-linear classifier, Bayesian classification, parametric and non-parametric classification techniques, minimum distance classifiers, K-NN rules, SVM.

Unsupervised learning and clustering. Syntactic approach to PR, Fuzzy set theoretic approach to PR. Learning and Neuro computing, genetic algorithms for PR, Hybrid techniques.

Applications of PR.

(v) Robotics: (ICE 1005/5)

Introduction: Background, classification, applications, specifications, drive systems, end effectors, mechanics and control of mechanical manipulators.

Spatial Descriptions and Transformations: introduction, position, orientation and frames, mapping, operators, transformation arithmetic, transform equations, computational consideration

Manipulator Kinematics and Dynamics: Link description, tool location and orientation, Inverse manipulator kinematics - solvability, example of inverse kinematics, repeatability and accuracy, Jacobians - velocities and static forces, manipulator dynamics, Lagrangian formulation of manipulator dynamics, Generalized D' Alembert equations of motion

Workspace Analysis and Trajectory Planning - path description and generation, collision free path planning

Linear Control of manipulators: Feedback and closed loop control, control of second order system, trajectory-following control, continuous vs. discrete time control, architecture of an industrial robot controller

Nonlinear Control of Manipulators: Nonlinear and time-varying system, multi input multi-output control system, control problem of manipulators, adaptive Control

Force Control of Manipulator: application of industrial robot to assembly tasks, hybrid position / force control problem, force control of a mass spring system

Sensing: Range, proximity, touch, force and torque sensors, integration of sensors, low level and high level vision, recognition and interpretation

Robot Programming: Languages and Systems - Different levels of robot programming, V AL programming language, robot intelligence and task planning, AI and robotics.

Implementation Principles, Social Issues and the Future of Robotics ,Telerobotics

(vi) Software Reliability (ICE 1005/6)

Review of probability & statistics, stochastic processes, Markov Models, Parameter estimation and hypothesis testing. Models of information systems, introduction to reliability measures. Estimation of MTF and other reliability parameters. Software metrics and software reliability models. Queuing network models, Workload design, Benchmarks, Estimations of performance metrics, case studies.

(vii) CAD for VLSI (ICE 1006/7)

Introduction: VLSI design flow, challenges. Verilog/VHDL: introduction and use in synthesis, modeling combinational and sequential logic, writing test benches. 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. Testability issues: fault modeling and simulation, test generation, design for testability, built-in self-test. Testing SoC's. Basic concepts of verification. 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.

(viii) Information System Management: (ICE 1005/8):

Concept of System software, application software, choice of software and programming languages; Data information and Knowledge; Database and database environment. Information systems (IS) different types of ESS, MIS, DSS, TPS. Business perspective, information as a strategic source, IS for competitive advantage. Implication for managers and organizations. Organizations and IS relationship and effect on each other.

Revisiting software development life cycles, Principles of conventional software engineering and modern software management.

Software metrics, Halstead software science, Putnam's project curve and time-cost trade-off, LOC and Function point measures of software size, Software time and cost estimation.

Project planning, scheduling, tracking and control, Time and cost overruns, Project organization, Staffing, Group working, Team dynamics.

Quality management and ISO 9000 quality assurance method, Configuration management, Quality reviews, Software standards, Tracking of defects, Process improvements, SEI/CMM models, Other process models.

Productivity, Business Process Reengineering. Dynamics of Software Project Management.

(ix) Wireless Sensor Network (ICE 1005/9):

Introduction : motivation, applications, sensors, architectures, platforms for WSN

Actual Systems: Berkeley motes, TinyOS and nesC.

Wireless Radio Realities - radio irregularities and impact on protocols.

MAC protocols - B-MAC, multi-channel MAC.

Routing - Flat Networks Routing, Hierarchical Network Routing, Location.

Based Routing, Negotiation Based Routing, Multi-Path based Routing, Query based Routing.

Clock Synchronization, Localization, Coverage of wireless sensor network.

Power Management - per node, system-wide, sentry services, sensing coverage.

Data Services and Databases - architectures, queries (SQL), data dissemination Security and Privacy - problems, attacks, solutions.

Programming Abstractions - programming models, Environment Tracking, new Apls.

Case Study, Self-Healing.

Summary - fundamentals, open research areas.