Revised Curriculum and Detailed Syllabi of
Six-semester Evening
Master of Technology in Computer Technology Course
Department of Computer Science & Engineering
Jadavpur University

as approved in FET meeting dated 29.4.2011

(Each lecture period is of 45 minutes duration)

Curriculum for Master of Technology in Computer Technology

FIRST SEMESTER

Theoretical Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Session al	Examination	Sessional	
Paper-I	PG / MTCT / T / 111A	Principles of Programming Languages	4		100		3
Paper-II	PG /MTCT / T/ 112A	Advanced Algorithms	4		100		3
Paper-III	PG / MTCT / T/ 113A	High Performance Computer Architecture	4		100		3

Sessional Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Session al	Examination	Sessional	
Sessional I	PG / MTCT / S / 111	Programming Lab		4		100	2
Sessional II	PG / MTCT / S / 112	Assignment		4		100	2
			12	**8**	**300**	**200**	**13**

Total Period/Week = 20 **Total Marks = 500**

SECOND SEMESTER

Theoretical Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Paper-IV	PG / MTCT / T / 121A	Advanced Operating Systems	4		100		3
Paper-V	PG /MTCT / T/ 122A	Database Technology and Data Mining	4		100		3
Paper-VI	PG / MTCT / T/ 123A	Theory of Computing	4		100		3

Sessional Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Sessional III	PG / MTCT / S / 121	Operating System Lab		4		100	2
Sessional IV	PG / MTCT / S / 122	Database and Data Mining Lab		4		100	2
			12	**8**	**300**	**200**	**13**

Total Period/Week = 20 **Total Marks = 500**

THIRD SEMESTER

Theoretical Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Paper-VII	PG /MTCT / T/ 211A	Artificial Intelligence	4		100		3
	PG /MTCT / T/ 211B	Wireless Communication & Protocols					
	PG /MTCT / T/ 211C	Information and Coding Theory					
	PG /MTCT / T/ 211D	Distributed Computing					
Paper-VIII	PG / MTCT / T/ 212A	Image Processing	4		100		3
	PG / MTCT / T/ 212B	Network Security					
	PG / MTCT / T/ 212C	Embedded Systems					
	PG / MTCT / T/ 212D	Computational Geometry					

Sessional Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Sessional V	PG /MTCT / S / 211	Seminar		4		100	2
			8	**4**	**200**	**100**	**8**

Total Period/Week = 12 **Total Marks = 300**

FOURTH SEMESTER

Theoretical Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Paper-IX	PG / MTCT / T / 221A	Pattern Recognition	4		100		3
	PG / MTCT / T / 221B	Natural Language Processing					
	PG / MTCT / T / 221C	Adhoc and Sensor Network					
	PG / MTCT / T / 221D	Computational Intelligence					
Paper-X	PG /MTCT / T/ 222A	Cryptography	4		100		3
	PG /MTCT / T/ 222B	Machine Learning					
	PG /MTCT / T/ 222C	Multimedia Technologies					
	PG /MTCT / T/ 222D	Bio-informatics					
	PG /MTCT / T/ 222E	Service Oriented Architecture					

Sessional Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Sessional VI	PG / MTCT / S / 221	Term Paper Leading to Thesis		4		100	2
			8	**4**	**200**	**100**	**8**

Total Period/Week = 12 **Total Marks = 300**

FIFTH and SIXTH SEMESTER (Run-Through)

Courses	**Subjects**		**Periods/Weeks**		**Marks**		**Credit Points**
	Subject Code	Subject Name	Lecture	Sessional	Examination	Sessional	
Sessional VII	PG / MTCT / S / 31	Thesis Work				300	8
	PG / MTCT / S / 32	Viva-Voce on Thesis				100	4
						400	**12**

Total Period/Week = 16 **Total Marks = 400**

Detailed Syllabi of
Six-semester Evening
M.Tech in Computer Technology Course
Dept. of Computer Science & Engineering
Jadavpur University

PG/MTCT/T/111A Principles of Programming Languages

Introduction: Programming language definition, brief history of programming languages, overview of programming paradigms. **2L**
Language design principles: Design criteria, efficiency, regularity. **1L**

Syntax: Lexical structure, Context free grammar, BNF, syntax tree, parse tree, S-expression syntax.
4L
Semantics: Declaration, allocation, evaluation, symbol table, runtime environment, data types, type checking, weak typing, strong typing, parameter passing methods such as pass by value, pass by name, pass by result, pass by value-result, pass by reference, exceptions and exceptions handling.
5L
Garbage collection: Advantages, explicit garbage collection, automatic garbage collection compacting. **1L**
Imperative programming: Impact of Von Neuman architectures on programming language, assignments, names, locations, L- value, R-value, memory allocation, scope rules, control flow, control abstraction, functions, exception handling, primitive and constructed data types, data abstraction.
4L
Object oriented programming: Objects, classes, methods, dynamic binding, inheritance, polymorphism, design and implementation issues in object-oriented languages, case study.
3L
Declarative programming: Distinctive features of declarative programming, first order logic, Horn clauses, resolution unification, sequencing of control, negation, implementations issues, the language Prolog, *constraint logic programming.*
9L

Functional programming: Distinctive features of functional programming languages, functional programming in imperative language, recursion, tail recursion, higher order functions, lazy evaluation, types in functional programming, mathematics of functional programming: lambda calculus. introduction to functional programming using Scheme/Haskell/ML. **9L**

Brief introduction to multi-paradigm languages (Python/Leda/Ada/C#). **3L**

Formal semantics: Operational semantics, denotational semantics, axiomatic semantics, proof of program correctness
3L

Parallel/Concurrent programming: Introduction to parallel processing, parallel processing and programming languages, concurrency semantics, threads, semaphores, monitors, message
passing, parallelism in non-imperative languages. **4L**

Suggested readings:

1. Kenneth C. Louden, Programming Languages: Principles and practice, 2003
2. D. A. Watt, *Programming Languages and Paradigms*, Prentice-Hall, 1990.
3. Benjamin C. Pierce, ed., Advanced Topics in Types and Programming Languages,
   MIT Press, 2005
4. J. Lloyd, *Foundations of Logic Programming*, Springer Verlag, 1984.
5. M. Hennessey, *The Semantics of Programming Languages*, John Wiley, 1990.
6. Luca Cardelli and P. Wegner, *On Understanding Types, Data Abstraction and Polymorphism*, Computing Surveys, 17(4), pp 471, 1985.
7. C. Reade, .*Elements of Functional Programming*, Addison Wesley, 1989.
8. Benjamin C. Pierce, Types and Programming Languages, MIT Press, 2002.

PG/MTCT/T/112A Advanced Algorithms

Review of Algorithm Analysis – Criteria for analysing algorithms, Concept of amount of work done, Asymptotic notations, Recurrences, Techniques for solving recurrences. **4L**

Review of Algorithm Design – Divide and Conquer, Dynamic Programming, Greedy Algorithms, Graph Algorithms. **4L**

Probabilistic Analysis and Randomized Algorithms **4L**

Median and order statistics **4L**

Amortized analysis **2L**

Linear programming **4L**

NP-completeness **4L**

Approximation algorithms **8L**

Special Topics: Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid's algorithm, modular exponentiation, primality

testing, cryptographic computations).
8L

Internet algorithms (text pattern matching, tries, information retrieval, data compression, Web caching). **6L**

Suggested readings:
1. T. Cormen, C. Leiserson, R. Rivest, and C. Stein. Introduction to Algorithms (2nd edition). MIT Press / McGraw-Hill
2. Michael T. Goodrich and Roberto Tamassia. Algorithm Design: Foundations, Analysis, and Internet Examples. John Wiley & Sons
3. J. Kleinberg and É. Tardos. Algorithm Design. Addison-Wesley, 2005

PG/MTCT/T/113A High Performance Computer Architecture

Introduction: Review of basic computer architecture, Quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.
4L
Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling.
2L
Pipeline optimization techniques. Compiler techniques for improving performance.
2L
Hierarchical memory technology: Inclusion, Locality properties; Cache memory organizations,
Techniques for reducing cache misses; Virtual memory organization, Mapping and management
techniques, Memory replacement policies.
6L
Instruction-level parallelism: Basic Concepts, Techniques for increasing ILP, Dynamic scheduling (Tomasulo's Algorithm), Reorder buffer and instruction commit, Branch prediction and advanced instruction delivery, Speculative execution. Superscalar, Super-pipelined and VLIW processor architectures.
8L
Array and vector processors.
2L
Multiprocessor architecture: Taxonomy of parallel architectures. Centralized shared-memory
Architecture. Synchronization, Memory consistency, Interconnection networks.
Distributed shared memory architecture. Model of memory consistency, Cache coherency, Multiprocessing snooping protocol, Multiprocessing directory protocol.
8L

Cluster computers.
2L
Non von Neumann architectures: Data flow computers, Reduction computer architectures, Systolic architectures.
2L
Multicore Arcitecture.
4L

Suggested readings:
1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach,
Morgan Kaufmann.
2. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar
Processors, Tata McGraw-Hill.
3. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing
4. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability,
McGraw-Hill.

PG/MTCT/T/121A Advanced Operating Systems

Overview of operating systems **2L**
OS kernel structures – microkernel, monolithic kernel – characteristics and privileged Operations **2L**
Process and Thread management (multicore processors) – Scheduling, synchronization
4L
Detailed Case Studies: Unix, Linux, Open Solaris, any Windows OS **10L**

Advanced File Systems – Examples : Unix Fast File Systems, Log-based File System, Google file systems, etc.
6L
Single Address space system – Opal **4L**
Real-time OS – Characteristics and features, Real-time Scheduling **4L**
Distributed OS – Characteristics, Scheduling (including load sharing/balancing), Distributed File systems
10L
Operating system for mobile devices – Characteristics and features with a Mobile OS as example **6L**

Suggested readings:
1. M. Singhal, N. Shivaratri, Advanced Concepts in Operating Systems, McGraw-Hill, 1994.

2. W. Stallings, Operating Systems - Internals and Design Principles, Prentice Hall, 1998.
3. W. Stallings, Operating Systems, Macmillian Publishing, 1992.
4. M. Seltzer, K. Bostic, K. Mckuisick, C. Stailin, An implementation of a Log-structured file system for Unix, Proc. of Winter USENIX, 1993.
5. M. K. Mckuisick, W. N. Joy, S. J. Lefer, R.S.Fabry, A Fast File System for Unix
6. B. N. Bershad, E. D. Lazowska, H. M. Levy, Scheduler Activations: Effective Kernel support for user-level management of parallelism.
7. T.E. Anderson, *ACM Transactions on Computer Systems*, Vol. 10, No. 1, February 1992, pp 53-79
8. J. Chase, H. Levy, M.B. Harvey, E. Lazowska, Opal: A Single Address Space System for 64-bit Architectures
9. P. K. Sinha, Distributed Operating Systems – Concepts and Design, IEEE Cs Press, PHI, 1997

PG/MTCT/T/122A Database Technology and Data Mining

Database Technology:

Introduction to DBMS, Review of Relational Model, Database Design based on ER/EER Diagram and Functional Dependency **4 L**

Introduction to query Optimization, Using Heuristics in Query Optimization, Cost Estimates **3 L**

Concept of Transaction, Crash Recovery (Log based Scheme, Check Point, Shadow Paging) **2 L**

Concurrency Control (Lock based Protocol, Timestamp based protocol, Validation Technique, Multiple Granularity, Multiversion Scheme) **3 L**

Recovery from Transaction Failure, Deadlock Handling **3 L**

Distributed Database Concepts (Introduction, Design, Transparency and Autonomy, Query Processing, Recovery, Commit Protocol, Concurrency, Deadlock, Coordinator Selection, Multidatabase System) **5 L**

Data Mining:

Data Warehouse and DBMS, Introduction to Data Mining and Scalability Issue **2 L**

Data Preprocessing: Cleaning, Transformation, Reduction, Discretization and Concept Hierarchy Generation. **3 L**

Knowledge Representation: Task Relevant Data, Background Knowledge, Interestingness Measures, Representing Input Data and Output Knowledge. **2 L**

Attribute-oriented Analysis: Attribute generalization, Attribute Relevance, Class

Comparison, Statistical Measures.
2 L

Association rules: Basic Idea: Item Sets, Generating Rules, Correlation Analysis. **3 L**
Classification: Basic Learning/Mining Tasks, Inferring Rudimentary Rules: **1L**
Algorithm, Decision Trees, Covering Rules. **3 L**
Prediction: The Prediction Task, Statistical (Bayesian) Classification, Bayesian Networks,
Instance-Based Methods: nearest neighbor, Linear models. **3 L**
Estimating Classifier Accuracy: Combining Multiple Models Bagging, Boosting, Stacking;
Holdout, Cross-validation methods, **3 L**
Clustering: Partitioning Methods- k-Means, Expectation Maximization (EM)
Hierarchical Methods: Distance-based Agglomerative and Divisible Clustering) **4 L**
Concepts of Text mining and Web Mining **2 L**

Suggested readings:

1. Fundamentals of Database Systems by E. Navathe
2. Database System Concepts by Korth and Silberschatz
3. Commercial Application Development Using Oracle Developer – 2000 by Bayross
4. Data Mining: Concepts and Techniques by J. Han & M. Kamber,
5. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten and Eibe Frank

PG/MTCT/T/123A Theory of Computing

Finite Automata and Regular expressions: closure properties, Kleen's theorem, Subset construction, Minimization, Pumping lemma. **8L**
Context free Grammars– closure properties, grammatical transforms, Normal Forms, Ogden's lemma, Push Down Automata, Equivalence of different modes of acceptance, relationship with CFL, pumping lemma for CFL.
8L
Turing Machines - variations, equivalence and simulation overheads, role as enumerator, restricted models.
8L
Universal Turing Machines, Recursively enumerable sets and undecidable problems, Rice's theorem, Post Correspondence problems - applications, Oracle computation **8L**
Hierarchy of grammars, deterministic and nondeterministic space and time complexity classes.
8L
Intractable problems- NP-complete problems, Cook's Theorem, PSPACE completeness.**8L**

Suggested readings:

Hopcroft JE. and Ullman JD., "Introduction to Automata Theory, Languages & Computation", Narosa.

John C. Martin: Introduction to languages and the theory of computation, 2nd Ed., McGraw Hill.
K.L.P Mishra & N. Chandrasekharan – "Theory of Computer Science", PHI
Lewis H. R. and Papadimitrou C. H., "Elements of the theory of Computation", P.H.I.
Kain, "Theory of Automata & Formal Language", McGraw Hill.

PG/MTCT/T/211A

Artificial Intelligence

Introduction

5L

Objectives and goals of AI, Turing tests, Different goals of AI, Symbolic approaches and sub-symbolic approaches, Connectionist approach, Subsumption architecture, Applications

Production Systems, control strategy and its variants

2L

Uninformed search techniques: State space search, BFS, DFS, Iterative Deepening DFS, Depth limited search, Uniform cost search

5L

Informed search: Heuristic search strategies – Greedy, Best-first serach , A* search

5L

Advanced Search strategies: Hill Climbing, Simulated Annealing, Beam search, Genetic Algorithm

5L

Knowledge Representation and reasoning

8L

Propositional calculus, resolutions of propositional calculus,(clause, WFF, sound ness of Resolution system), Horn cclause, Predicate calculus and its importance, Resolution in the predicate calculus.

Uncertain information management

6L

Case based reasoning, reasoning with uncertain information, Fuzzy logic: Set theory, composition, relation, rules and rule based systems.

Agent Technology: Types of agents, Multiple Agents, Multiagent Systems, Game theory.
5L

Planning: Classical Planning, Planning Graph, Hierarchical Planning and multiagent planning.

5L

Applications of AI.
2L

Suggested readings:
1. Nils J. Nilson: Principles of Artificial intelligence, Narosa
2. Russel Norvig : Artificial intelligence : a modern approach, Pearson
3. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd., 2000.
4. Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.

PG/MTCT/T/211B Wireless Communication and Protocol

Introduction to Wireless Communication Technology **1L**
Overview: Channel Access Techniques – FDMA, TDMA, CDMA, SDMA **2L**
Telecommunication Systems: Architecture, Mobility Management, Security, Services:
GSM, EDGE **5L**
GPRS, EGPRS **5L**
UMTS, W-CDMA
5L
Wireless LAN: Technical Issues, Network Architecture:
IEEE 802.11 Standard **5L**
HIPERLAN **3L**
Bluetooth: Architecture, Protocol stack, Security, Profiles **6L**
Mobile Network layer:
Mobile IP, DHCP **4L**
Introduction to Adhoc Networks:
Characteristics, Overview of routing protocols – DSDV, AODV, DSR **3L**
Mobile Transport layer:
Overview of traditional TCP; TCP over 2.5G / 3G network **3L**
Wireless Application Protocol:
Architecture, Protocol stack **4L**
Introduction to WML / WMLScript **2L**

Suggested readings:
1. Mobile Communications - Jochen Schiller, Pearson Education
2. Wireless Communications and Networking - W. Stallings, PHI
3. Ad Hoc Wireless Networks*:* Architectures and Protocols - C. Siva Ram Murthy and B. S. Manoj, Pearson Education
4. Charles Perkins – Adhoc Networking, Pearson Education
5. Wireless and Mobile Network Architecture – Lin and Chalmac, Wiley

PG/MTCT/T/211C # Information and Coding Theory

Information Theory

Introduction to Information Theory	**1 L**
Information and Entropy	**1 L**
Joint Entropy	**2 L**
Mutual Information	**1 L**
Extension of a zero Memory Source	**1 L**
Source Encoding, Kraft's Inequality, Huffman Coding	**3 L**
Shannon's 1st Fundamental Theorem	**1 L**
Markov Source, Adjoint Source and Extension of Markov Source	3 L
BSC, BEC	**2 L**
Capacity of Symmetric and Asymmetric Channel	**2 L**

Coding Theory

Introduction to Coding Theory	**1 L**
Block Codes:	
Introduction	**1 L**
Parity Check Code, Product code, Repetition Code	**2 L**
Hamming Code, Minimum Distance of Block Codes	**2 L**
Review of Linear Algebra and Galois Field	
Set, Group, Field, Vector Spaces, Matrices	**2 L**
Roots of Equation, GF(2p), Primitive Field Element, Irreducible and Primitive Polynomial, Minimal Polynomial	**4 L**
Linear Codes:	
Definition, Systematic Format, Generator and Parity Check Matrices	**2 L**
Syndrome and Error Detection	**2 L**
Standard Array and Syndrome Decoding	**2 L**
Hamming Code	**1 L**
Cyclic Codes:	
Definition, Generator Polynomial and Its Properties, Parity Check Polynomial	**3 L**
Encoding and Decoding	**2 L**
Cyclic Hamming Code	**1 L**
Error Trapping Decoder	**2 L**
Introduction to BCH Codes and Reed-Solomon Codes	**4 L**

Suggested readings:

1. Principles of Digital Communication – Das, Mukherjee, Chatterjee
2. Introduction to Error Control Codes – S. Gravano
3. Error Control Coding: Fundamentals and Applications – Shu Lin, Danilel J. Costello, Jr.
4. Information Theory, Coding and Cryptography – Ranjan Basu

PG/MTCT/T/211D # Distributed Computing

Introduction to distributed systems:
4L
Goals, hardware & software concepts, the client-server model, Comparison of distributed systems with P2P, cluster, Grid, cloud etc. Strengths and weakness of distributed computing

Forms of computing:
2L
Monolithic, distributed, parallel, cooperative

Communication: **4L**
Layered protocols, RPC, remote object invocation, message-oriented communication

Distributed computing paradigms: **5L**
Message passing, client server, P2P, remote procedure call model, distributed objects, object space, collaborative application (groupware)

Socket: **2L**
Socket metaphor, datagram socket API, stream mode socket API, sockets with non blocking I/O, secure socket API

Java RMI Architecture: **2L**
Client side, Server Side, object registry

API for Java RMI: **4L**
Remote Interface, Server side software, client side software, RMI vs Socket

Advanced RMI: **3L**
Client callback, stub downloading, RMI security manager

Group Communication: **2L**
Unicasting, multicasting, connection oriented & connectionless, reliable and unreliable multicast, Java basic multicast API

Internet Applications:
5L
HTML, XML, HTTP, Applets, Servlets, Web services, SOAP

Mobile Agents: **2L**
Basic architecture, advantages, mobile agent framework systems, design, implementation using Java RMI

Distributed coordination-based systems JINI:
5L

Runtime environment, architecture, discovery protocol, join protocol, lookup service, distributed event, distributed leasing, transactions, surrogate architecture

Basics of Grid Computing: **4L**

Computational Grid, Data Grid, Grid Architecture, Networking Infrastructure, Protocols and Quality of Service, Grid Scheduling, Resource Management, Resource Brokers, Security

Basics of Cloud: **4L**

Cloud Computing architecture, Cloud computing infrastructure requirements and limitations, Protocols and Quality of Service, security

Suggested readings:

1. Distributed Computing: Principles and Applications, M. L. Liu, Pearson/Addison-Wesley.
2. A Programmer's Guide to Jini Technology, Jan Newmarch, Apress.
3. A. Taunenbaum, Distributed Systems: Principles and Paradigms, PHI
4. G. Coulouris, J. Dollimore, and T. Kindberg, Distributed Systems: Concepts and Design, Pearson Education
5. Core Jini, W. Kieth Edwards, Apress.

PG/MTCT/T/212A

Image Processing

Introduction **4L**

Digital Images, Fundamental steps in Digital Image Processing, Components of Digital Image Processing system. Digital Image Fundamentals-Neighbourhood, Connectivity, boundaries, Relations, Distance Measures, Arithmetic/Logic Operations,

Image Acquisition and Representation **5L**

Fundamental of visual perception, Image acquisition, Fundamentals of CCD Camera, Scanner, visual and other domains. Image sampling and quantization. Representation in different file formats. Different image categories.

Image Enhancement **6L**

Gray Level transformations, Histogram processing

Spatial Domain Methods- Mean and median filters, Image Sharpening.

Enhancements in the frequency domain – Fourier transform, Low pass filtering, High pass filtering, Ideal, Butterworth, and Gaussian Filters.

Image Restoration **4L**

Differences in noise removal and restoration, noise models, degradation Model, Different spatial and frequency domain filters, Estimation of degradation function, Inverse filters; Wiener Filtering, Geometric Transformation - Spatial Transformation, Gray Level Interpolation.

Image Segmentation **6L**

Point Detection, Line Detection, Edge detection- first order and second order gradients. Thresholding – Global and/or optimal thresholding techniques; Region-based segmentation, Region Growing, Region Splitting and Merging.

Colour Image Processing **4L**

Colour models, Colour transformations, Smoothing and sharpening of colour images, colour image segmentation.

Morphological Image Processing **4L**

Dilation, Erosion, Opening, Closing, Hit-or-miss transformation, Boundary extraction, thinning, Descriptors for binary regions. Extension of these operators to gray level images with applications.

Image Compression **7L**

Concept of redundancy, different redundancies, Fidelity criteria, Image compression models.

Lossless compressions: Huffman coding, Arithmetic coding, LZW coding, Lossless Predictive coding.

Lossy compressions: Lossy predictive coding, Transform coding, wavelet coding etc

Compression standards.

Image Understanding and analysis **8L**

Different image representation and description techniques, Boundary descriptors, Texture analysis,

Medical image processing, Document analysis, Content based image retrieval etc.

Suggested readings:

1. Digital Image Processing, Gonzalez and Woods, Pearson
2. Digital Image Processing, Castleman, Pearson
3. Digital Image Processing, Jahne, Springer India
4. Digital Image Processing & Analysis, Chanda & Majumder,PHI
5. Fundamentals of Digital Image Processing, A. K. Jain, PHI

PG/MTCT/T/212B Network Security

Introduction: Security Goals, Threats, Vulnerabilities and Attacks, Types of Attacks, Security Services and Mechanisms

2L

Cryptographic Tools: Symmetric Key Cryptography, Block Ciphers, Stream Ciphers, DES, IDEA, AES, Asymmetric Key Cryptography, RSA, ElGamal Cryptosystems, Elliptic Curve Cryptosystems, Message Integrity and Message Authentication, Cryptographic Hash Functions, Digital Signatures, Key Management, Kerberos

4 L

Security at Network Layer: IP Security Overview, IP Security Architecture, Security Association, Authentication Header, Encapsulated Security Payload, Internet Key Exchange, ISAKMP **4 L**

Security at Transport Layer: SSL Architecture, Four SSL Protocols, SSL Message Format, Transport Layer Security, HTTPS, SSH

6 L

Security at Application Layer: Email Security, PGP, S/MIME

4L

Firewalls and Intrusion Prevention Systems: Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configuration, Intrusion Prevention Systems **4 L**

Intrusion Detection Systems: Intruders, Intrusion Detection, Host Based Intrusion Detection, Network Based Intrusion Detection, Distributed Intrusion Detection, Intrusion Detection Exchange Format, Honeypots

4 L

Denial of Service Attacks: Denial of Service Attacks, Flooding Attacks, Distributed Denial of Service Attacks, Reflector and Amplifier Attacks, Defences against Denial of Service Attacks, Responding to a Denial of Service Attack

4 L

Malicious Software: Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Bots, Botnets, Rootkits

4 L

Software Security: Buffer Overflow Attacks, Defence against Buffer Overflows, Handling Program Inputs, Writing Safe Program Codes, Interaction with Operating System and Other Software **4 L**

Wireless Network Security: Authentication and Authorization in Wireless LANs, Data Protection in Wireless LANs, Security in MANET

8 L

Suggested readings:

1. **Computer Security: Principles and Practices**, by William Stallings and Larry Brown, First Edition, 2008, Pearson Education
2. **Network Security: Private Communication in a Public World** by Charlie Kaufman, Radia Perlman and Mike Speciner, Second Edition, 2003, Prentice Hall India

3. **Cryptography and Network Security**, by William Stallings, Fifth Edition, , Prentice Hall, 2010
4. **Cryptography and Network Security** by Behrouz A. Forouzan and Debdeep Mukhopadhyay, Second Edition, 2010, Tata McGraw Hill
5. **Network Security Essentials: Applications and Standards**, by William Stallings, Edition, , Pearson Education
6. **Security in Computing**, by Charles P. Pfleeger, Shari Lawrence Pfleeger, 4th Edition, 2007, Prentice Hall
7. **Security in Wireless LANs and MANs** by Thomas Hardjono and Lakshminath R. Dondeti, Artech House, 2005

PG/MTCT/T/212C Embedded Systems

Introduction, Definitions, Constituents of embedded systems, application areas, various categories of embedded systems. **3L**
Architecture of embedded systems: hardware, software, memory, Communication interfaces. **8L**
Overview of 8051 Microcontroller, Digital Signal Processors and FPGA. **8L**
Overview of Embedded/real-time operating systems **3L**
Simulation with VHDL. **4L**
Implementation with FPGA. **4L**
Hardware-software co-design. **4L**
Partitioning Hardware-Software. **4L**
Functional Partitioning and Optimization. **4L**
Low Power Embedded System Design. **4L**
Testing of Embedded System **2L**

Suggested readings:

1. Embedded/Real-time Systems:Concepts Design and Programming by Dr. K.V.K.K. Prasad, Dreamtech Press.
2. Programming for Embedded Systems, Dreamtech Software team, Wiley-Dreamtech India Pvt.
3. Embedded System Design by S. Chattopadhyay, PHI
4. Embedded System Design - A unified Hardware/ Software Introduction by F. Vahid, T. Givargis, Willey India Edition
5. Embedded System Design with Platform FPGAs – Principles and Practices by R.Sass A.G.Schmidt, Morgan_kaufman Publisher

PG/MTCT/T/212D Computational Geometry

1. Geometric Objects – Points, Lines, Planes, Polygons, 3D Objects – Geometric Algorithms – Degeneracies and Robustness – Application Domains

   4L
2. Convex Hull in 2D – Incremental Algorithm **3L**
3. Line Segment Intersection Algorithms – Doubly Connected Edge List – Map Overlays – Boolean operations

   6L
4. Polygon Triangulation – Partitioning Polygons into Monotone Pieces – Triangulation of Monotone Polygons – Art Gallery Problem

   8L
5. Half Plane Intersections – Use of Linear Programming Techniques – Manufacturing with Moulds

   6L
6. Orthogonal Range Searching – Kd Trees – Range Trees – Higher Dimensional Range Trees – Database Searching – Point Location **8L**
7. Voronoi Diagrams – VD of Line Segments – Farthest Point VDs – Post Office Problem

   6L
8. Convex Hulls in 3-space **4L**
9. Robot Motion Planning – Work Space and Configuration Space – Translational Motion Planning

   3L

Suggested readings:

1. Computational Geometry – Algorithms and Applications by Berg, Cheong, Kreveld and Overmars 3e, Springer
2. Computational Geometry – An Introduction by Preparata and Shamos, Springer
3. Computational Geometry in C – Joseph O'Rourke, 2e, Cambridge Univ Press

PG/MTCT/T/221A Pattern Recognition

Basics of pattern recognition, Problems in Pattern Recognition, Pattern Recognition System Design, Template Matching, Decision Functions, Hyperplane and its Properties, Curse of Dimensionality, Dimensionality Reduction, Accuracy, Error Surface, Error Rate and Error Bound, Computational Complexity, Examples and Applications

4L

Feature Generation: Basic Concepts, Basis Vectors, Principal Component Analysis, Singular Value Decomposition, Discrete Cosine and Sine Transform, Discrete Fourier Transform, Discrete Wavelet Transform, Regional Features, Features for Shape and Size Characterization.

5L

Feature Selection: Preprocessing, Data Normalization, Feature Selection Based on Statistical Hypothesis Testing, Class Separability Measure, Feature Subset Selection.

4L

Bayesian decision theory: Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features

4L

Parameter estimation methods: Maximum-Likelihood estimation, Bayesian estimation

3L

Non-parametric techniques for density estimation: Parzen-window method, K-Nearest Neighbour method.

3L

Linear Classifiers: Perceptron, Least Square Method, Support Vector Machines

4L

Nonlinear Classifier: Multilayer Perceptron, Backpropagation Algorithm, Polynomial Classifier, Radial Basis Function Networks, Nonlinear Support Vector Machines.

5L

Context-Dependent Classification: Bayes Classifier, Markov Chain Models, Hidden Markov Model.

5L

Clustering: Sequential and Hierarchical Clustering, k-means, c-means Algorithms, Vector Quantization, Cluster Validity

6L

Syntactic Pattern Recognition: Grammar Based Approach and Applications, CYK Parsing Algorithm, Graphical Approaches, Learning Via Grammatical Inference

5L

Suggested readings:

1. R. O. Duda, P. E. Hart and D. G. Stork, "Pattern Classification," John Wiley, 2001

2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition," 4th Ed., Academic Press, 2009

3. C. M. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006

4. R. Schalkoff, "Pattern Recognition," Wiley, 2007.

5. K. Fukunaga, "Introduction to Statistical Pattern Recognition," Academic Press, 1990

PG/MTCT/T/221B Natural Language Processing

Regular Expressions and Automata:

2 L

Introduction to NLP, Regular Expression, Finite State Automata

Tokenization

6 L

Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance

Morphology

6 L

Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer

Language Modeling

6 L

Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models.

Hidden Markov Models and POS Tagging

4 L

Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging – Rule based and Machine Learning based approaches, Evaluation

Text Classification

4 L

Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis – Opinion Mining and Emotion Analysis, Resources and Techniques

Context Free Grammar

8 L

Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing

Computational Lexical Semantics

4 L

Introduction to Lexical Semantics – Homonymy, Polysemy, Synonymy, Thesaurus – WordNet, Computational Lexical Semantics – Thesaurus based and Distributional Word Similarity

Information Retrieval

8 L

Boolean Retrieval, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency

based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback

Suggested readings:

1. Speech and Language Processing - Jurafsky and Martin, Pearson Education
2. Foundations of Statistical Natural Language Processing – Manning and Schutzer, MIT Press

PG/MTCT/T/221C Adhoc and Sensor Network

Fundamentals of Wireless Communication	**1L**
Overview: Channel Access Techniques, Wireless LANs	**3L**
Cellular Architecture and Cellular Systems	**3L**
Introduction to Wireless Adhoc Networks: Issues and Challenges	**2L**
MAC Protocols:	
Issues, design goals, classifications	**2L**
Contention-based protocols (MACAW, MACA-By Invitation)	**2L**
Contention-based protocols with Reservation Mechanisms (Distribution Packet Reservation Multiple Access protocol, Collision Avoidance Time protocol)	**2L**
Contention-based protocols with Scheduling Mechanisms (Distributed Priority Scheduling and Medium Access in Adhoc Networks, Distributed Wireless Ordering Protocol)	**2L**
Mobile Adhoc Networks: Characteristics, Classification of Routing protocols	**1L**
Routing protocols:	
DSDV, WRP, CGSR, HSR, FSR	**4L**
AODV, DSR, ABR, ZRP	**4L**
QoS in Adhoc Networks	**2L**
Energy Management in Adhoc Networks	**2L**
Overview of Fault Tolerance and Reliablity of Adhoc Networks	**2L**
Overview of Security in Adhoc Networks	**1L**
Wireless Sensor Networks: Introduction, Issues and Challenges	**1L**
Sensor node: architecture and functionalities	**1L**
Localization: Techniques (GPS-based and non-GPS-based)	**2L**
Concepts of Clustering, Clusterhead selection	**2L**
Routing protocols: Categorization	
SPIN and its variants, Directed Diffusion, Rumuor Routing	**3L**
LEACH, PEGASIS, Energy aware routing	**3L**
Overview of TinyOS	**2L**
Security in WSN	**1L**

Suggested readings:

1. Ad Hoc Wireless Networks*:* Architectures and Protocols- C. Siva Ram Murthy and B. S. Manoj, Pearson Education

2. Wireless Communications Systems and Networks – ed. M. Guizani. Springer
3. Wireless and Mobile Network Architecture – Lin and Chalmac, Wiley
4. J.N. Al-Karaki, A.E. Kamal, Routing techniques in wireless sensor networks: a survey, IEEE Wireless Communications. 11 (6) (2004) 6–28.
5. Charles Perkins – Adhoc Networking, Pearson Education

PG/MTCT/T/221D Computational Intelligence

Mimicking Nature for Problem Solving: The Basic Concepts, Biological versus Artificial neural networks, Biological basis for Evolutionary Computations, Chromosomes.
4L

Computational Intelligence: Adaptation: Adaptation versus Learning, three types of adaptation, three spaces of adaptation; Self-organizing and adaptation, CI as self-organizing and adaptation, CI versus AI.

4
L

Artificial Neural Networks: Neural Networks Components and Terminology, Neural Networks Topology, Neural Networks Adaptation: Hebbian Adaptation, Competitive Adaptation, Error Correction Adaptation; Single-layer and multi-layer feedforward and feedback neural networks, radial basis function (RBF) neural networks, support vector machines (SVM), Kohonen Neural Networks, LVQ, ART Map, Applications.
12L

Associative memories.
2L

Fuzzy sets and fuzzy logic: Fuzzy set theory: membership function, linguistic variables, linguistic hedges, Approximate Reasoning: fuzzy rules, fuzzification, measure of fuzziness. **8L**

Fuzzy neural networks.
2L

Evolutionary Computing: Basis concepts, Genetic algorithms: GA operations, schemata and schema theorem, Evolution strategies: Prediction, function optimization.
4L

Probabilistic reasoning: Elements of probability theory, belief propagation, DS theory.
4L

Swarm Intelligence and Ant colony optimization: Particle swarm and Ant colony optimization. **4L**

Artificial Immune Systems: Biological communication among antibodies, Immune system model. **2L**

Computational complexity of Computational Intelligence models.
2L

Suggested readings:

1. Computational Intelligence: Concepts to Implementations, Russell Eberhart and Yuhui Shi, Morgan Kaufmann Publishers, 2007.
2. Computational Intelligence: Principles, Techniques, and Applications, Amit Konar, Springer.
3. Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models, Vojislav Kecman, MIT press.

PG/MTCT/T/222A Cryptography

Introduction to Cryptography
6L

Cryptosystem. Encryption and Decryption. Cryptographic Attacks. Notions of Security. Perfect Secrecy. Symmetric and Asymmetric Key Cryptosystems. Block and Stream Ciphers.

Stream Ciphers
6L

Primitive polynomials, m-sequences, Combiner and Filter functions, Software stream Ciphers

DES
6L

Data Encryption Standard, Tripple DES, other variants.

AES
6L

Finite Field and Extension field arithmetic, Design of AES, Key scheduling of AES

Attacks on Cryptosystems
8L

Differential Cryptanalysis. Linear Cryptanalysis. Correlation Attacks. Algebraic Attacks.

Public Key Cryptosystems
6L

Rabin, ElGamal, RSA, Elliptic Curve Cryptography.

Practical Applications
6L

Pseudorandom Number Generation. Hash Functions. Identification and Authentication. Digital Signatures. Key Distribution. Key Agreement. Public key infrastructure.

Advanced Topics
4L

Secret Sharing. Multiparty Computation. Zero-knowledge Protocols.

Suggested readings:

1. "Fundamentals of Computer Security", by Josef Pieprzyk, Thomas Hardjono and Jennifer Seberry (Springer), 2008.
2. "Cryptography: Theory and Practice", by Douglas Stinson, CRC Press, 2006.
3. "Applied Cryptography: Protocols, Algorithms, and Source Code in C", by Bruce Schneier, Wiley, 1996.
4. "Handbook of Applied Cryptography", by Alfred Menezes, Paul van Oorschot and Scott Vanstone, CRC Press, 1996.

PG/MTCT/T/222B Machine Learning

Introduction:

2 L

Machine learning applications, concepts learning

Introduction to Bayesian learning theory:

5L

Regression, feature selection, supervised learning, class conditional probability distributions,
Examples of classifiers Bayes optimal classifier and error, learning classification approaches,
handling continuous attributes.

Decision tree learning algorithms:

5 L

Inference model, general domains, symbolic decision trees, consistency, learning trees from
training examples, entropy, mutual information, ID3 algorithm, handling continuous and missing attributes, confidence, overfitting, pruning, learning with incomplete data

Perceptron and Neural Networks

5 L

Single layer neural network, linear reparability, general gradient descent, perceptron learning
algorithm, multi-Layer perceptron: two-layers universal approximators, backpropagation learning, important parameters.

Instance-based Learning:

2L

Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability,

Machine learning concepts and limitations:

5 L

Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and

realizable case, VC-dimension, PAC learning, fundamental algorithm independent concepts, hypothesis class, target class, inductive bias, occam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.

Machine learning assessment

1 L

Statistical model selection, structural risk minimization

Ensemble learning methods: Voting, bagging, boosting.

2 L

Unsupervised learning:

2 L

Introduction, Hierarchical clustering, K- means clustering

Semi-supervised learning:

2 L

Introduction, self-training, co-training

Sequence learning: Hidden Markov Model (HMM), Viterbi algorithm

4 L

Curse of dimensionality: Subset selection, **PCA**

2 L

Support Vector Machines:

5 L

Margin of a classifier, dual perceptron algorithm, learning non-linear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier.

Assessing and comparing learning algorithms: Bootstrapping, K-fold cross validation, hypothesis testing

2 L

Reinforcement Learning: Control learning, Q-learning, Convergence

4 L

Suggested readings:

1. T. M. Mitchell, **Machine Learning**, McGraw-Hill, 1997.
2. E. Alpaydin**, Introduction to Machine Learning**, Prentice Hall of India, 2006.
3. C. M. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006.
4. R. O. Duda, P. E. Hart, and D.G. Stork, **Pattern Classification**, John Wiley and Sons, 2001.
5. Vladimir N. Vapnik, **Statistical Learning Theory**, John Wiley and Sons, 1998.
6. Shawe-Taylor J. and Cristianini N., Cambridge, **Introduction to Support Vector**

Machines, University Press, 2000.

PG/MTCT/T/222C Multimedia Technology

Introduction
Multimedia and its Application, Different Media, Hypertext and Hypermedia, Issues in Multimedia System, Component of a Multimedia System
2 L

Overview of Text and Graphics:
Types of Text Data (Plain/Formatted/Hypertext), Unicode Scheme, Concept of Font, File Formats (txt, doc, rtf, ps, pdf etc.), Vector and Raster Graphics
2 L

Image:
Image Digitization, Digital Image, Binary/GrayScale/ Colour Image, Colour Models, File Formats
2 L

Contrast Intensification (Linear Stretching, Histogram Equalization), Noise Removal by Filtering **2 L**
Different Gradient based Edge Detection Technique
2 L

Segmentation by Feature Thresholding and Region based Approach (Region Growing/ Splitting/ Merging)
4 L

Image Descriptors (Shape, Texture and Colour Features) **3 L**
Loss-less and Lossy Image Compression including JPEG **3 L**
An overview of Content Based Image Retrieval System
3 L

Audio:
Audio Digitisation (Sampling and Quantization, Representation based on PCM/DPCM/DM/ADM), File Format
2 L

Time Domain Descriptors (ZCR, STE etc.), Frequency Domain Descriptors (Spectral Centroid, Spectral Flux, Spectral Roll Off etc.), and Perception based Descriptors (Mel Scale, MFCC) **3 L**
Psycho Acoustics and Audio Compression **2 L**
An Overview of Audio Classification/Retrieval System
3 L

Video:
Structure of Video Data, File Format **1 L**
Video Compression **2 L**
Motion Estimation **1 L**

Structural Segmentation of Video Data

4 L

Overview of Video Summarization, Browsing and Retrieval System

3 L

Animation:

Keyframes and Tweening, Cel and Path Animation, Principles and Techniques of Animation, Web Animation, 3D Animation Principles, Camera, Special Effects, Transformations and Editing, Rendering Algorithms

4 L

Suggested readings:

1. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods
2. Digital Image Processing and Analysis by B. Chanda and D. Dutta Majumder
3. Principles of Multimedia by Ranjan Parekh

PG/MTCT/T/222D

Bioinformatics

Introduction to Molecular Biology: Central dogma of Molecular Biology, Translation, Transcription

4L

Study of Biological Databases:

NCBI, PIR, PDB, SCOP **6L**

Comparative Genomics:

Pair wise Sequence Alignment, Multiple Sequence Alignments
Fragment Assembly, Gene Finding, Phylogenetic Tree Analysis

8L

Proteomics:

Protein Structure Predictions and Analysis: Primary, Secondary and Tertiary, super family classification

8L

Expression Profile Analysis:

Analysis of Micro array Gene Expression Data, Finding Biomarkar

6L

Analysis of Gene Regulatory Network **4L**

Protein-Protein Interaction: Viral host interaction, human-human interaction, prediction of protein-protein interaction

4L

Metabolic Pathway:

Understanding the Pathway Databases (KEGG), Signal transduction

4L

Rational Drug Design: Active Site Identification, docking and design

4L

Suggested readings:

1. Neil C. Jones and Pavel A. Pevzner. An Introduction to Bioinformatics Algorithm, MIT Press, 2004.
2. Pevzner, P. Computational Molecular Biology, MIT press, 2000.
3. Warren J. Ewens and Gregory R. Grant, Statistical Methods in Bioinformatics: An Introduction, Springer, 2005.
4. Teresa K. Attwood and David J. Parry-Smith, Introduction to Bioinformatics, Pearson Education, 2003.
5. Auther M. Lesk, Introction to Bioinformatics, Oxford University Press, 2008.
6. Campbell A.M and Heyer, L. J. Discovering genomics, proteomics and bioinformatics, Benjamin Cummings, 2002.
7. Paul G. Higgs and Teresa K. Attwood. Bioinformatics and Molecular Evolution, Blackwell Publishing, 2005.
8. Zoe Lacroix and Terence Critchlow, Bioinformatics: Managing Scintific Data, Morgan Kaufmann (Elsevier), 2003.
9. Durbin, Eddy, Krogh, Michinson, Biological Sequence Analysis, Cambridge, 1998.
10. Gusfield D. Algorithms on Strings, Trees, and Sequences, Cambridge University Press, 1997.

PG/MTCT/T/222E Service Oriented Architecture

SOA Fundamentals:
8L

Introduction & Evolution of Service Computing / Orientation, Business Alignment and Value of Service Orientation, Defining SOA, Business Value of SOA, Evolution of SOA, SOA characteristics, concept of a service in SOA, Basic SOA architecture, infrastructure services, Enterprise Service Bus (ESB), SOA Enterprise Software models, SOA Principles.

Service Definition: **4L**

Autonomy, ABC- addressing, Binding, Contract, Proxy, Web Service as an example of Service implementation, Web Service Protocol Fundamentals.

SOA Planning and Analysis:
8L

Stages of the SOA lifecycle, SOA Delivery Strategies, service-oriented analysis, business centric SOA and its benefits,Service modeling, Basic modeling building blocks, service models for legacy application integration and enterprise integration, Enterprise solution assets(ESA).

SOA Design and implementation: **8L**

Service-oriented design process, design activities, determine services and tasks based on business process model, choosing appropriate standards, articulate architecture, mapping business processes to technology, designing service integration environment (e.g., ESB, registry), security implementation, implementation of integration patterns, services enablement, quality assurance.

Standards: **4L**

WS Policy, WS Metadata, WSDL as WS- Metadata

Communication and SOA: **6L**

SOAP, XML Serialization, Formatter- binary formatter, SOAP formatter, WS addressing, WS event, WS security, WS authorization, WS secure conversation, WS security policy, WS trust.

Managing SOA Environment: **10L**

Distributing service management and monitoring concepts, operational management challenges, Service-level agreement considerations, SOA governance (SLA, roles and responsibilities, policies, critical success factors, and metrices), QoS compliance in SOA governance, role of ESB in SOA governance, impact of changes to services in the SOA lifecycle.

Suggested readings:

1. Thomas Erl, “Service-Oriented Architecture: Concepts, Technology, and Design”, Prentice Hall Publication, 2005.

2. Norbert Bieberstein, Sanjay Bose, Marc Fiammante, Keith Jones, Rawn Shah, “Service-Oriented Architecture Compass: Business Value, Planning, and Enterprise Roadmap”, IBM Press Publication, 2005.

3. Sandy Carter, “The New Language of Business: SOA & Web 2.0”, IBM Press, 2007.

4. Thomas Erl, “Service-Oriented Architecture: A Field Guide to Integrating XML and Web Services”, Prentice Hall Publication, 2004.

5. Dave Chappell, “Enterprise Service Bus”,O'Reilly Publications, 2004.

6. Sanjiva Weerawarana, Francisco Curbera, Frank Leymann, Tony Storey, Donald F.Ferguson, “Web Services Platform Architecture: SOAP, WSDL, WS-Policy, WS- Addressing, WS-BPEL, WS-Reliable Messaging, and More”, Prentice Hall Publication, 2005.

7. Eric Newcomer, Greg Lomow, “Understanding SOA with Web Services”, Addison Wesley Publication, 2004.