Scheme and Syllabus
of
Master of Technology
(Information Technology)
Batch 2015

By
Board of Studies CSE/IT/AMT
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<th>Course Code</th>
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1\textsuperscript{st} Semester
MTCS-101 Advanced Software Engineering

Section- A

Formal Methods: Basic concepts, mathematical preliminaries, Applying mathematical notions for formal specification, Formal specification languages, using Z to represent an example software component, the ten commandments Of formal methods, Formal methods- the road ahead.

Section- B
Component-Based Software Engineering: CBSE process, Domain engineering, Component-based development, Classifying and retrieving components and economics of CBSE.

Client/Server Software Engineering: Structure of client/server systems, Software engineering for Client/Server systems, Analysis modeling issues, Design for Client/Server systems, Testing issues

Section- C
Web Engineering: Attributes Of web-based applications, the WebE process, a framework for WebE. Formulating, Analysing web-based systems, design and testing for web-based applications, Management issues.

Reengineering: Business process reengineering, Software reengineering, Reverse reengineering, Restructuring, Forward reengineering, economics of reengineering.

Section- D

Computer-Aided Software Engineering: Building Blocks for CASE, taxonomy Of CASE tools, integrated CASE environments, Integration architecture, and CASE repository

Recommended Books
MTCS-102 ADVANCED COMPUTER ARCHITECTURE

Section-A

Fundamentals of Processors: Instruction set architecture; single cycle processors, hardwired and micro-coded FSM processors; pipelined processors, multi-core processors; resolving structural, data, control and name hazards; analyzing processor performance.

Section-B

Fundamentals of Memories: memory technology; direct-mapped, associative cache; write-through and write-back caches; single-cycle, FSM, pipe-lined cache; Analyzing memory performance.

Section-C

Advanced Processors: Super scalar execution, out-of-order execution, register renaming, memory disambiguation, dynamic instruction scheduling, branch prediction, speculative execution; multi-threaded, VLIW and SIMD processors.

Section-D

Advanced Memories: non-blocking cache memories; memory protection, translation and virtualization; memory synchronization, consistency and coherence.

Recommended Books:

MTCS-103 INFORMATION SECURITY

Section -A

Section- B

Section-C

Internet Security Protocols: SSL, TLS, IPSEC, S/MIME.

Section- D


Suggested Readings
MTCS-104 Advanced Database Systems

**Section A**


**Advanced Transaction Processing and Concurrency Control:**
Transaction Concepts, Concurrency Control: Locking Methods, Timestamping Methods, Optimistic Methods for Concurrency Control, Concurrency Control in Distributed Systems.

**Section B**

**Query Compiler:** Introduction, parsing, generating logical query plan from parse tree.


**Query Evaluation:** Introduction, Approaches to QE, Transformation of relational expressions in Query optimization, heuristic optimization, cost estimation for various operations, transformation rule.

**Section C**

**Distributed Database**
Centralized DBMS and Distributed DBMS, functions and architecture of a DDBMS, Distributed Data Storage, Transparency issues in DDBMS, Query Processing DDBMS, Distributed transaction Management and Protocols, Distributed Concurrency Control and Deadlock Management.

**Object Oriented Database**
Limitations of RDBMS, Need of Complex Datatype, Data Definition, ODBMS Fundamentals, issues in OODBMS, Object-oriented database design.Comparison of ORDBMS and OODBMS.

**Section D**
Emerging Database Models, Technologies and Applications

Multimedia database-Emergence, difference from other data types, structure, deductive databases, GIS and spatial databases, Knowledge database, Information Visualization, Wireless Networks and databases, Personal database, Digital libraries, web databases, case studies.

References

1. Advanced database management system by RiniChkrabarti and ShibhadraDasgupta, Dreamtech.
2. Distributed Databases by Ozsu and Valduriez, Pearson Education.
3. Fundamentals of Database Systems by RamezElmasri, ShamkantNavathe, Pearson Education
MTCS-105 DIGITAL IMAGE PROCESSING

Section-A


Section-B


**Image Enhancement:** Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background, Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications.

Section-C


Section-D

**Image Segmentation:** Edge Detection - Line Detection - Curve Detection - Edge Linking And Boundary Extraction, Boundary Representation, Region Representation And Segmentation, Morphology-Dilation, Erosion, Opening And Closing. Hit And Miss Algorithms Feature Analysis

**Color and multispectral Image processing:** Color Image-Processing Fundamentals, RGB Models, HSI Models, Relationship Between Different Models. Multispectral Image Analysis -
Color Image Processing Three Dimensional Image Processing-Computerized Axial Tomography-
Stereometry-Stereoscopic Image Display-Shaded Surface Display.

**Text Book:**

1. Rafael. C. Gonzalez & Richard E.Woods.- Digital Image Processing, 2/e Pearson Education,
   New Delhi - 2006

**Reference Books:**


2. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India


2\textsuperscript{nd} Semester
MTRM-101 Research Methodology

METHODS OF RESEARCH:
Nature and Objectives of research; historical, descriptive and experimental. Study and formulation of research problem. Scope of research and formulation of hypotheses; Feasibility, preparation and presentation of research proposal.

INTRODUCTION TO STATISTICAL ANALYSIS:
Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis. Probability and probability distributions; Binomial, Poisson, Geometric, Negative binomial, Uniform, Exponential, Normal and Log-normal distribution. Basic ideas of testing of hypotheses; Tests of significance based on normal, t and Chi-square distributions. Analysis of variance technique.

DESIGN OF EXPERIMENTS:
Basic principles, study of completely randomized and randomized block designs. Edition and tabulation of results, presentation of results using figures, tables and text, quoting of references and preparing bibliography. Use of common softwares like SPSS, Mini Tab and/or Mat Lab. For statistical analysis.

BOOKS RECOMMENDED:
1. G. C. Ramamurthy, Research Methodology, Dreamtech Press,
MTCS-201 ADVANCED DATA STRUCTURES


Approximation algorithms: Need of approximation algorithms: Introduction to P, NP, NP-Hard and NP-Complete; Deterministic, non-Deterministic Polynomial time algorithms; Knapsack, TSP, Set Cover, Open Problems.

Randomized Algorithms: Introduction, Type of Randomized Algorithms, Quick Sort, Min-Cut, 2-SAT; Game Theoretic Techniques, Random Walks.

Recommended Books:

MTCS-202 Soft Computing


Fuzzy Logic: Introduction to Fuzzy logic, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Membership functions, Defuzzification, Fuzzy Arithmetic and Fuzzy measures, Fuzzy Rule base and approximate reasoning, Fuzzy decision making


Hybrid Soft Computing Techniques: An Introduction, Neuro-Fuzzy Hybrid Systems, Genetic Neuro-Hybrid systems, Genetic fuzzy Hybrid and fuzzy genetic hybrid systems,

References:


2. NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHM: SYNTHESIS AND APPLICATIONS By S. RAJASEKARAN, G. A. VIJAYALAKSHMI, PHI.

MTCS-203 Software metrics

**Basics of measurement**: Measurement in everyday life, measurement in software engineering, scope of software metrics, representational theory of measurement, measurement and models, measurement scales, meaningfulness in measurement, goal-based framework for software measurement, classifying software measures, determining what to measure, software measurement validation, empirical investigation, types of investigation, planning and conducting investigations.

**Software-metrics data collection and analysis**: What is good data, how to define the data, how to collect the data, how to store and extract data, analyzing software-measurement data, frequency distributions, various statistical techniques.

**Measuring internal product attributes**: Measuring size, aspects of software size, length, functionality and complexity, measuring structure, types of structural measures, control-flow structure, modularity and information flow attributes, data structures.

**Measuring external product attributes**: Modeling software quality, measuring aspects of software quality, software reliability, basics of software reliability, software reliability problem, parametric reliability growth models, predictive accuracy, recalibration of software-reliability growth predictions, importance of operational environment, wider aspects of software reliability.

**Metrics for object-oriented systems**: Intent and characteristics of object-oriented metrics, various object-oriented metric suites LK suite, CK suite and MOOD metrics.

**Dynamic Metrics**: Runtime Software Metrics, Extent of Class Usage, Dynamic Coupling, Dynamic Cohesion, and Data Structure Metrics.

**Metrics for component-based systems**: The intent of component-based metrics, distinguishing characteristics of component-based metrics, various component-based metrics.

**Resource measurement**: Measuring productivity, teams, tools, and methods.

**REFERENCES**:


MTCS-204 NATURAL LANGUAGE PROCESSING

Introduction: Natural Language Processing (NLP), Challenges of NLP, NLP Applications, Processing of Indian Languages.

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields, Scope Ambiguity and Attachment Ambiguity resolution.

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.


Meaning: Lexical Knowledge Networks, WorldNet Theory; Indian Language Word Nets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors.

Speech Recognition: Signal processing and analysis method, Articulation and acoustics, Phonology and phonetic transcription, Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Recommended Books:
MTCS-205 ADVANCED OPERATING SYSTEM

**Distributed operating system:** Architectures, Issues in Distributed operating systems, Limitations of Distributed Systems, Lamport’s logical clock, Global states, Chandy-Lampert’s global state recording algorithm, Basic concepts of Distributed Mutual Exclusion, Lamport’s Algorithm, Ricart-Agrawala Algorithm; Basic concepts of Distributed deadlock detection, Distributed File system, Architecture, Design issues, SUN Network File system Basic concepts of Distributed shared memory, Basic concepts of Distributed Scheduling, Load balancing, Load sharing.


**Distributed OS Implementation:** Models, Naming, Process migration, Remote Procedure Calls.

**Failure Recovery and Fault Tolerance:** Basic Concepts-Classification of Failures, Basic Approaches to Recovery; Recovery in Concurrent System; Synchronous and Asynchronous Checkpointing and Recovery; Checkpointing in Distributed Database Systems; Fault Tolerance; Issues - Two-phase and Nonblocking Commit Protocols; Voting Protocols; Dynamic Voting Protocols

**Multiprocessor System:** Definition, Classification, Multiprocessor Interconnections, Types, Multiprocessor OS functions & requirements; Design & Implementation Issue; Introduction to parallel programming; Multiprocessor Synchronization.

**Real Time Operating systems:** Fundamentals of real time operating systems, real time multitasking, embedded application, preemptive task scheduling, inter-task communication and synchronization.

**Analytic Modeling:** Introductions, Queuing Theory, Markov Process.

**BOOKSRECOMME NDED**

3. Advanced Concepts in Operating Systems - Mukesh Singhal and Niranjan G. Shivaratri, TMH
MTCS-206 CLOUD COMPUTING

**Introduction:** Cloud Computing definition, Cloud Types- Private, Public and Hybrid cloud. Cloud Services: Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Pros and Cons of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. Benefits and challenges of cloud computing.

**Virtualization:** Definition, Type of Virtualization, Benefits, Limitations, Virtualization and Cloud, Virtual Appliance.

**Cloud-based Data Storage:** Introduction to MapReduceforSimplifieddataprocessingonLargeclusters, Designof dataapplicationsbasedonMapReduceinApacheHadoop,TaskPartitioning, Datapartitioning, DataSynchronization,DistributedFilesystem,DataReplication.

**Cloud Services:** Introduction, Contrast traditional software development and development for the cloud. Technologies and the processes required when deploying web services; deploying a web service from inside and outside a cloud architecture, advantages and disadvantages, Public vsPrivate cloud apps.

**Management of Cloud Services:** Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics-Cloud Computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization-application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat).

**Open Source Cloud Computing and Testing:** OpenStack, OpenNebula-underlying technologies, Cloud Monitoring-Ganglia; Physical and virtual machine memory, CPU management and abstraction techniques using a hypervisor. Software Testing in the Cloud - SMART-T- Migrating Testing to the Cloud, HadoopUnit- Test Execution in the Cloud.

**Advance Topics:** Mobile Cloud Computing, Big-Data and Internet of Things (IoT): Definition of Big-Data, Structured and Unstructured Data, V’s of Big-Data, Hadoop, Definition of IoT, Characteristics of IoT, Combining Big-Data, IoT and Cloud Computing.

**Text Books and References:**
MTCS-207 Data Warehousing and Data Mining

**Data warehousing:** Introduction, ETL, Data warehouses—design guidelines for data warehouse implementation, Multidimensional Models; OLAP—introduction, Characteristics, Architecture, Multidimensional view and data cube, Data cube operations, data cube computation.

**Review of the Basic Data Analytic Methods using R:** Introduction to R—look at the data, Analyzing and Exploring the Data, Statistics for Model Building and Evaluation.

**Data mining:** Introduction, association rules mining, Naive algorithm, Apriori algorithm, direct hashing and pruning (DHP), Dynamic Item set counting (DIC), Mining frequent pattern without candidate generation(FP, growth), performance evaluation of algorithms,

**Classification:** Introduction, decision tree, tree induction algorithms—split algorithm based on information theory, split algorithm based on Gini index; naïve Bayes method; estimating predictive accuracy of classification method;

**Cluster analysis:** Introduction, partitional methods, hierarchical methods, density based methods, dealing with large databases, cluster software;


**Recommended Books:**

1. Carlo Vercellis, Business Intelligence: Data mining and Optimization for Decision Making, WILEY.
MTCS-208 Service Oriented Architecture

**Introduction:** Characteristics and Anatomy of SOA, Comparing SOA to client-server and distributed internet architectures, SOA component interrelation, Principles of service orientation. Major components of the architecture SOAP, XML, HTTP, Cookies, WSDL, XML schema, UDDI.

**Introduction to Web services:** Service descriptions, Messaging with SOAP, Message exchange Patterns, Coordination, Atomic Transactions, Business activities, Orchestration, Choreography, Service layer abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer.

**Analysis:** Service oriented analysis, Business-centric SOA, Deriving business services-service modeling, Service Oriented Design, WSDL basics, SOAP basics, SOA composition guidelines, Entity-centric business service design, Application service design, Task-centric business service design.

**SOA platform basics:** SOA support in J2EE, Java API for XML-based web services (JAX-WS), Java architecture for XML binding (JAXB), Java API for XML Registries (JAXR), Java API for XML based RPC (JAX-RPC), Web Services Interoperability Technologies (WSIT), SOA support in .NET, Common Language Runtime, ASP.NET web forms, ASP.NET web services, Web Services Enhancements (WSE).

**Security:** WS-BPEL, WS-Coordination, WS-Choreography, WS-Policy, WS-Security.

**Recommended Books**


3rd Semester
MTIT- 301 Web Analytics and Intelligence

Section- A
Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, On site web; Web analytics platform, Web analytics evolution, Need for web analytics.

Data Collection: Clickstream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

Section- B
Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, Creating and running a survey, Benefits of surveys.

Web Analytic fundamentals: Capturing data: Web logs or JavaScripts tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding clickstream data quality, Identifying unique page definition, Using cookies, Link coding issues.

Section- C
Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non-e-commerce sites). Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Section- D
Web analytics 2.0: Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data,

Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities.

Recommended Books:
MTCS- 302 Big Data Analytics

Section- A
An Overview of Big Data and Big Data Analytics. Understanding Hadoop Ecosystem (Hadoop Distributed File System, MapReduce, Hadoop YARN, HBase, Combining HBase and HDFS, Hive, Pig, Sqoop, ZooKeeper, Flume, Oozie). MapReduce Framework, Techniques to Optimize MapReduce Jobs, Role of HBase in Big Data Processing

Section- B
Developing Simple MapReduce Application, Points to Consider while Designing MapReduce. Controlling MapReduce Execution with InputFormat, Reading Data with Custom RecordReader, Organizing Output Data with OutputFormats, Customizing Data with RecordWriter, Optimizing MapReduce Execution with Combiner, Controlling Reducer Execution with Partitioners.

Section- C

Section- D

References:
2. Big Data Computing and Communications edited by Yu Wang, Hui Xiong, Shlomo Argamon, XiangYang Li, JianZhong Li Springer
MTIT- 302 WIRELESS SENSOR NETWORKS

**Fundamentals:** Sensor Basics, Types, Functions, Applications and limitations of sensors—Temperature, Current, Pressure and Strain, Position, Capacitive sensing, Humidity sensors, Light Sensors, Optical Sensors, Sound and Vibrations. Vision of Application Environment-Ambient Intelligence and associated applications.

**Sensor Network Architecture:** Sensor network scenarios, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.


**Infrastructure Establishment:** Topology Control, Node Clustering algorithms, Node Clustering Algorithms for WSNs, Time Synchronization-Basic concept, Requirement in WSN. Concepts and Challenges of Node Localization and Positioning in WSN, Sensor Tasking and Control.

**Sensor Network Platforms And Tools:** Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

**TEXT BOOKS:**


**REFERENCES**

MTIT- 303 Intrusion Detection and Analysis

Introduction and an Overview of Intrusion Detection Systems:
Introduction, Purpose, Scope, Applications and Need of intrusion detection systems, Firewalls and intrusion detection systems, challenges to intrusion detection system.

Intrusion Detection Systems and Associated Methodologies:
Uses of Intrusion detection technologies, Key Functions of Intrusion detection systems, Common Detection Methodologies, Signature-Based Detection, Anomaly-Based Detection, stateful protocol analysis

Operational Lifecycle of Open-Source IDS
Planning, installation, configuration, running, customization, auditing, refinement, and updating. Flow process for Snort and Bro, Similarities and differences between Snort and Bro.

Snort-Introduction, Planning, including deployment scenarios, Running-Modes of operation: sniffer, packet logger, NIDS, Plug-ins, Customization-Writing Snort rules, Refining-Solutions for dealing with false negatives and positives, Writing a rule for a vulnerability

Bro-Introduction, Planning-Operational modes, Running-BroControl to manage Bro, Running in standalone mode, Running in cluster mode, Customization-Understanding and deploying Bro’s policy neutral features

Using and Integrating Multiple Intrusion Detection Systems Technologies
Need for Multiple IDS technologies, Integrating Different IDS Technologies, Direct IDS Integration, Indirect IDS Integration, Other Technologies with IDS Capabilities, Network Forensic Analysis, Anti-Malware Technologies, Honeypots

Host-Based IDS and Network Behavior analysis

Recommended Books:
MTIT- 304 NETWORK SECURITY AND ETHICAL HACKING

Introduction
Network Security, Functionality and ease of use Triangle, Essential Terminology and Elements of Security (Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit), Concept of ethical hacking
Phases involved in hacking, Penetration Testing and Ethical Hacking

Foot Printing
Introduction to foot printing, Information gathering methodology of the hackers, Active and passive reconnaissance

Scanning
Scanning, Elaboration phase, active scanning. Enumeration, DNS Zone transfer. Detecting live systems on the target network, Discovering services running /listening on target systems, Understanding port scanning techniques, Identifying TCP and UDP services running on the target network, Understanding active and passive fingerprinting

System Hacking
Aspect of remote password guessing, Role of eavesdropping ,Various methods of password cracking, Key(stroke) Loggers, Understanding Sniffers and their working, Comprehending Active and Passive Sniffing, Man-in-the-Middle Attacks, ARP Spoofing/Poisoning and Redirection, DNS and IP Sniffing, HTTPS Sniffing.

Trojans and backdoors: Trojan, Overt and Covert Channels, Working of Trojans, Different Types of Trojans, Different ways of Trojan’s entry into a system, Indications of a Trojan Attack

Session Hijacking
Understanding Session Hijacking, Spoofing vs. hijacking, Phases involved in Session Hijacking, Types of Session Hijacking, Session hijacking Tools.

Hacking Wireless Networks
Introduction to 802.11, Role of WEP, Cracking WEP Keys, Sniffing Traffic, Wireless DOS attacks, WLAN Scanners, WLAN Sniffers, Hacking Tools, Securing Wireless Networks.

Recommended Books:
2. Ethical Hacking, Thomas Mathew, OSB Publisher, 28-Nov-2003.
MTCS-306 Advanced AI

Section- A

Section-B
Basic Search Strategies: Problem spaces (states, goals and operators), Problem solving by search, Factored representation (factoring state into variables), Uninformed search (breadth-first, depth-first, depth-first with iterative deepening), Heuristics and informed search (hill-climbing, generic best-first, A*), Space and time efficiency of search, Constraint satisfaction (backtracking and local search methods).
Advanced Search: Constructing search trees, Dynamic search space, Combinatorial explosion of search space, Stochastic search: Simulated annealing, Genetic algorithms, Monte-Carlo tree search, Implementation of A* search, Beam search, Minimax Search, Alpha-beta pruning, Expectimax search (MDP-solving) and chance nodes.

Section-C
Knowledge Representation: Propositional and predicate logic, Resolution in predicate logic, Question answering, Theorem proving, Semantic networks, Frames and scripts, conceptual graphs, conceptual dependencies.
Reasoning under Uncertainty: Review of basic probability, Random variables and probability distributions: Axioms of probability, Probabilistic inference, Bayes’ Rule, Conditional Independence, Knowledge representations using Bayesian Networks, Exact inference and its complexity, Randomized sampling (Monte Carlo) methods (e.g. Gibbs sampling), Markov Networks, Relational probability models, Hidden Markov Models, Decision Theory Preferences and utility functions, Maximizing expected utility.

Section-D
Agents: Definitions of agents, Agent architectures (e.g., reactive, layered, cognitive), Agent theory, Rationality, Game Theory Decision-theoretic agents, Markov decision processes (MDP), Software agents, Personal assistants, and Information access Collaborative agents, Information-gathering agents, Believable agents (synthetic characters, modelling emotions in agents), Learning agents, Multi-agent systems Collaborating agents, Agent teams, Competitive agents (e.g., auctions, voting), Swarm systems and Biologically inspired models.

Suggested readings