Syllabus
for
M. Tech. (Computer Engineering)
M. Tech(Computer Science)
M. Tech. (Computer Science & IT)
M. Tech. (Computer Science & Engg.)
w.e.f. July 2017

Department of Computer Engineering

Master of Technology (Computer Engineering)

Sr No	Code	Course Name	Teaching Scheme				Examination Scheme				
			L	P	T	CR	IA	MSE	ESE	OR	Total
Semester I											
1	MTCE1101	Computer Algorithms	3		1	4	20	20	60		100
2	MTCE1102	Machine Learning	3		1	4	20	20	60		100
3	MTCE1103	Advanced Computer Networks	3		1	4	20	20	60		100
4	MTCE1104	Elective I	3			3	20	20	60		100
5	MTCE1105	Elective II	3			3	20	20	60		100
6	MTCE1106	Communication Skill	2			2	25			25	50
7	MTCE1107	Software Lab I		4		2	25			25	50
		Total	17	4	3	22	150	100	300	50	600
Semester II											
1	MTCE1201	Data Science	3		1	4	20	20	60		100
2	MTCE1202	Software Architecture	3		1	4	20	20	60		100
3	MTCE1203	Elective III	3			3	20	20	60		100
4	MTCE1204	Elective IV	3			3	20	20	60		100
5	MTCE1205	Elective V	3			3	20	20	60		100
7	MTCE1207	Software Lab II		4		2	50			50	100
8	MT CE1208	Seminar I		4		2	50			50	100
		Total	15	8	2	21	200	100	300	100	700
Semester III											
1	MTCE2101	Project Management and Intellectual Property Rights (Self Study)				2	50			50	100
3	MTCE2103	Project- I				10	50			50	100
		Total				12	100			100	200
Semester IV											
1	MTCE2201	Project-II				20	100			100	200
		Total				20	100			100	200

List of Electives

Elective 1
1. Cloud Computing
2. Game Theory
3. Natural Language Processing
4. Social Network Analysis

Elective 2
1. Intrusion Detection System
2. Model Checking
3. Artificial Intelligence and Knowledge Reasoning
4. High Performance Computing

Elective 3
1. Software Testing
2. Algorithms for Big Data-structures
3. Software Language Engineering
4. Cryptography and Network Security

Elective 4
1. Introduction to Cognitive System
2. Virtual Reality
3. Mobile Computing
4. Storage Systems

Elective 5:
1. Functional Programming
2. Object Oriented Systems
3. Reinforcement Learning
4. Pattern Recognition

MTCE1101: Computer Algorithms

L:3 T:1 P:0 MSE:20 CA:20 ESE:60

Prerequisites: Data-structures.

Course Contents

Advanced Data Structures: Red-Black Trees, B-Trees, Binomial Heap, Fibonacci Heap Data Structures for Disjoint Sets.

Graph algorithm: Search algorithms, computation of strongly connected components, shortest distance algorithms, minimum spanning tree algorithms.

Network-flow algorithm: Ford-Fulkerson method; preflow-push algorithm

Geometric algorithm: convex-hull computation, line-segment intersection computation, closest-pair computation.

String matching: Rabin Karp algorithm, Knuth-Morris-Pratt algorithm, Boyer-Moore algorithm

Matrix algorithms: Strassen's multiplication algorithm, LU decomposition, inverse computation

Polynomial computation algorithms: multiplication using DFT, division

Number theoretic algorithms: division, solution of modular linear equation, primality testing.

REFERENCES:

1. Cormen, Leiserson, Rivest, "Introduction to Algorithms", McGraw Hill.
2. Aho, Hopcroft, Ullman, " The Design and Analysis of Computer Algorithms", Addison Wesley.

NPTEL Course

1. Computer Algorithms – 2 by Prof. Shashank K. Mehta, IIT Kanpur.

MTCE1102: Introduction to Machine Learning

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Basic programming skills (in Python), algorithm design, basics of probability & statistics

Course Contents

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation.

Linear regression, Decision trees, overfitting.

Instance based learning, Feature reduction, Feature Selection, Collaborative filtering based recommendation.

Probability and Bayes learning, Evaluation Measures, Hypothesis Testing.

Logistic Regression, Linear Classification, Support Vector Machine, Kernel function and Kernel SVM.

Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network.

Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning ad methods.

Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.

Expectation Maximization, Introduction to Reinforcement Learning.

REFERENCES:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.
3. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
4. Introduction to Machine Learning Edition 2, by Ethem Alpaydin.
5. Darren Cook Practical Machine Learning with H2O Oreilly 2017

NPTEL Courses:

1. Introduction to Machine Learning by Dr. Balaraman Ravindran, IIT Madras.
2. Introduction to Machine Learning by Prof. S. Sarkar, IIT Kharagpur.

MTCE1103: Advanced Computer Network

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Computer Network.

Course Contents

Review to Fundamentals of Computer N/Ws, TCP/IP reference model, Interior and Exterior Gateways routing application layered protocols such as DHCP, BOOTP OSI, TCP/IP, ATMX.25, frame relay, switching techniques in communication system.

Fundamentals of Optical Networks, SONET/SDH Introduction, TDM Networks elements, Generation of optical N/W’s.

Introduction to key optical node Organization and key other terms, Cross connect Terminology, brief introduction to TDM and WDM, Evolution of optical system, Key Attributes of optical fiber, Digital Multiplexing Hierarchy, Characterization of optical fiber, timing and Synchronization.

Fiber Optic Technologies History, Basic fundamentals Operation, Physical properties, networking elements. Wavelength Division Multiplexing Principle of Operation, CDM/DWDM, and WDM networks elements, Impairments and Compensation in WDM.

SONET/ SDH Multiservice platform. Protection / Restoration and diversity in optical N/W's, MPLS/GMPLS introduction.

REFERENCES:

1. Optical Networks Control, Bala Rajagopalan, Gerg Bernstein, Debanjan saha.
2. Optical Networks and WDM, Walter J. Goralski, McGraw-Hill 2001.
3. Computer Networks: A System Approach, Larry L. Peterson, Bruce S. Davie, Morgan Kaufmann.
4. WDM Optical Networks: Concepts, Design and Algorithms, C. Siva Ram Murthy, Prentice Hall of New Jersey USA.

MTCE1104: Cloud Computing (Elective I)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Distributed Systems, Computer Networks

Course Contents

Unit1: Introduction to distributed and cluster computing, Basics of the emerging cloud computing paradigm, Cloud Benefits (10)
Unit 2: Virtualization concepts and types, KVM, VM Scheduling (8)
Unit 3: Disaster Recovery, Scaling (6)
Unit 4: Cloud security, Regulatory and compliance issues, VM Security Issues (6)
Unit 5: Latest Research Paper Topics (10

Text Books:

1. Cloud Computing, Michael Miller, Pearson, 2012
2. Cloud Computing: Implementation, Management, and Security, , John Ritting house and James F.Ransome, CRC Press Taylor and Francis Group, 2009
3. Dan Kusnetzky , "Virtualization: A Manager's Guide", 1st Edition ,O'Reilly,2011
4. Tim Mather Cloud Security and Privacy, Oreilly 2015

References:

1. Barrie Sosinsky, "Cloud Computing Bible", 1 st Edition ,Wiley India Pvt Ltd,2011.
2. Robert Elsenpeter, Toby J. Velte, Anthony T. Velte, "Cloud Computing : A Practical Approach", 1st Edition, Tata Mcgraw Hill Education, 2011.

4. Handbook of Cloud Computing , Borko Furht, Armando Escalante , Springer, 2010

NPTEL/Open Course Course

1. **Yogesh Simmhan, Introduction to Cloud Computing, www.serc.iisc.ac.i/~simmhan**

MTCE1104: Game Theory: (Elective-1)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

1 Introduction and Outline of the Course, Definitions, Utilities, Rationality, Intelligence, Common Knowledge, Classification of Games

I. **NON-COOPERATIVE GAME THEORY** Extensive Form Game Strategic Form Games with Illustrative Examples Dominant Strategy Equilibria Pure Strategy Nash Equilibrium with Illustrative Examples and Key Results Mixed Strategy Nash Equilibrium with Illustrative Examples and Key Results such as the Nash Theorem Computation of Nash Equilibria and introduction to algorithmic theory Matrix Games: Saddle Points, Minimax Theorem Bayesian Games, Bayesian Nash Equilibrium Evolutionary Game Theory (ESS Strategies) Repeated Game

II. **MECHANISM DESIGN** The Mechanism Design Environment Social Choice Functions with Illustrative Examples Implementation of Social Choice Functions Incentive Compatibility and Revelation Theorem 6 Gibbard-Satterthwaite and Arrow Impossibility Theorem Vickrey-Clarke-Groves (VCG) Mechanisms Bayesian Mechanisms (dAGVA) Revenue Equivalence Theorem Myerson Optimal Auction Further Topics in Mechanism Design

PART III: COOPERATIVE GAME THEORY Correlated Strategies and Correlated Equilibrium The Nash Bargaining Problem Coalitional Games (Transferable Utility Games) The Core The Shapley Value Other Solution Concepts: Kernel, Nucleolus To Probe Further and Conclusion

Reference Books

1. Martin J. Osborne. An Introduction to Game Theory. Oxford University Press. Indian Edition, 2003.
2. Roger B. Myerson. Game Theory: Analysis of Conflict. Harvard University Press, 1991.
3. Y. Narahari, Dinesh Garg, Ramasuri Narayanam, Hastagiri Prakash.
4. Game Theoretic Problems in Network Economics and Mechanism Design Solutions. Springer,

London, 2009.

NPTEL/Open Course

1. http://lcm.csa.iisc.ernet.in/gametheory/index.html

Natural Language Processing

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: A previous course on Artificial Intelligence will help. Courses of Data Structures and Algorithms should have been done. Exposure to Linguistics is useful, though not mandatory.

Course Contents

Introduction, Machine Learning and NLP, ArgMax Computation WSD: WordNet, Wordnet;

Application in Query Expansion, Wiktionary; semantic relatedness, Measures of WordNet Similarity, Similarity Measures, Resnick's work on WordNet Similarity, Parsing Algorithms, Evidence for Deeper Structure;

Top Down Parsing Algorithms, Noun Structure; Top Down Parsing Algorithms, Non-noun Structure and Parsing Algorithms, Probabilistic parsing; sequence labeling, PCFG, Training issues;

Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities, Speech : Phonetics, HMM, Morphology, Graphical Models for Sequence Labelling in NLP, Phonetics, Consonants (place and manner of articulation) and Vowels, Forward Backward probability;

Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, Text Entailment, POS Tagging, Phonology;

ASR, Speech Synthesis, HMM and Viterbi, Precision, Recall, F-score, Map, Semantic Relations; UNL; Towards Dependency Parsing, Universal Networking Language, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

REFERENCES:

1. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
3. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
4. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

NPTEL Course:

1. Natural Language Processing by Prof. Pushpak Bhattacharyya, IIT Bombay.

MTCE1104: Social Network Analysis (Elective I)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Course Contents

Introduction, Network Analysis.

Properties of Social Networks.

Community Analysis.

Case Study: Citation Networks.

REFERENCE:

1. Networks: An Introduction, Oxford University Press, Oxford, 2010.
2. Evolution of Networks, Oxford University Press, Oxford, 2003.
3. The structure and function of complex networks, SIAM Review 45, 167-256, 2003.
4. Statistical mechanics of complex networks, Rev. Mod. Phys., 74(1), 2002.
5. Social Network Analysis for Startup Tsvetovat, 2015 Oreilly.

NPTEL Course:

1. Complex Network : Theory and Application by Prof. Animesh Mukherjee, IIT Kharagpur.

MTCE1105: Intrusion Detection System (Elective 2)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Intruder types, intrusion methods, processes and detection, message integrity and authentication, honey pots.

General IDS model, data mining based IDS, Denning model, data mining framework for constructing features and models for intrusion detection systems

Unsupervised anomaly detection, CV5 clustering, SVM, probabilistic and statistical modeling, general IDS model and taxonomy, evaluation of IDS, cost sensitive IDS.

NBAD, specification based and rate based DDOS, scans/probes, predicting attacks, network based anomaly detection, stealthy surveillance detection; Defending against DOS attacks in scout: signature-based solutions, snort rules.

Host-based anomaly detection, taxonomy of security flaws in software, self-modeling system calls for intrusion detection with dynamic window size.

Secure intrusion detection systems, network security, secure intrusion detection environment, secure policy manager, secure IDS sensor, alarm management, intrusion detection system signatures, sensor configuration, signature and intrusion detection configuration, IP blocking configuration, intrusion detection system architecture

Reference Books

1. Endorf, C., Schultz E. and Mellander J., "Intrusion Detection and Prevention," McGraw-Hill. 2003
2. Bhatnagar, K., "Cisco Security", Course Technology. 2002
3. Marchette, D. J., "Computer Intrusion Detection and Network Monitoring: A Statistical Viewpoint", Springer. 2001
4. Rash, M., Orebaugh, A. and Clark, G., "Intrusion Prevention and Active Response: Deploying Network and Host IPS", Syngress. 2005
5. Cooper, M., Northcutt, S., Fearnow, M. and Frederick, K., "Intrusion Signatures and Analysis", Sams. 2001

MTCE1105: Model Checking (Elective 2)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Familiarity with basic algorithms and finite-state machines preferable

Course Contents

Modeling systems as Finite-state machines, Using the model-checker NuSMV, Linear-time properties for verification, Regular properties – automata over finite words, Omega-regular properties – automata over infinite words, Model checking omega-regular properties, Linear Temporal Logic (LTL), Algorithms for LTL, Computation Tree Logic (CTL), Algorithms for LTL, Models with timing constraints – timed automata, More on timed automata, Probabilistic models I, Probabilistic models II, Probabilistic models III.

REFERENCES:

1. Principles of Model-checking, Christel Baier and Joost-Pieter Katoen, MIT Press (2008).

NPTEL Course:

1. Model Checking by Prof. B. Srivathsan, CMI.

MTCE1105 Artificial Intelligence: Knowledge Representation and Reasoning

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Some exposure to formal languages, logic and programming**.**

Course Contents

Introduction: Introduction to Knowledge Representation and Reasoning and Formal Logics.
Propositional Logic: Language, Semantics and Reasoning, Syntax and Truth Values, Valid Arguments and Proof Systems, Rules of Inference and Natural Deduction, Axiomatic Systems and Hilbert Style Proofs, The Tableau Method, The Resolution Refutation Method.
First Order Logic(FOL): Syntax, Semantics, Entailment and Models, Proof Systems, Forward Chaining, Unification, Forward Chaining Rule Based Systems, The Rete Algorithm, Programming in a Rule Based Language, The OPS5 Expert System Shell.
Representation in FOL: Skolemization, Knowledge Representation, Properties and Categories, Reification and Abstract Entities, Resource Description Framework(RDF), Event Calculus: Reasoning About Change.
Mapping Natural Language to FOL: Understanding=Fulfilling Expectations, Conceptual Dependency (CD) Theory, Understanding Language, Conceptual Analysis: Mapping English to CD Theory.
Programming in Logic: Deductive Retrieval in Backward Chaining, Logic Programming, Prolog, Depth First Search and Efficiency Issues, Controlling Search, The Cut Operator in Prolog.
Theorem Proving in FOL: Incompleteness of Forward and Backward Chaining, The Resolution Refutation Method for FOL, Clause Form and The Resolution Rule, FOL with Equality, Complexity.
Knowledge Structures: Semantic Nets using Frames, Scripts, Script Applier Mechanism(SAM), Goals, Plans and Actions, Plan Applier Mechanism(PAM): Expectations and Recognition, PAM: Top Down and Bottom Up Reasoning.
Ontology and Description Logics: A Description Logic, Normalisation, Structure Matching, Classification, A-box Reasoning, Extensions, ALC, Further Extensions.
Inheritance: Taxonomies and Inheritance, Beliefs, Credulous and Skeptical Reasoning.
Default Reasoning: Introduction to Default Reasoning, Circumscription, Minimal Models, The Event Calculus Revisited, Default Logic, Autoepistemc Logic.
Reasoning in Multi-agent Systems: Epistemic Logic: Kripke Semantics in a Multi Agent Scenario, The Muddy Children Puzzle.

REFERENCES:

1. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

NPTEL Course

MTCE1105: High Performance Computing (Elective 2)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Computer programming, Data structures.

Course Contents

Program Execution: Program, Compilation, Object files, Function call and return, Address space, Data and its representation.

Computer Organization: Memory, Registers, Instruction set architecture, Instruction processing.

Pipelined Processors: Pipelining, Structural, data and control hazards, Impact on programming.

Virtual Memory: Use of memory by programs, Address translation, Paging.

Cache Memory: Organization, impact on programming, virtual caches.

Operating Systems: Processes and system calls, Process management.

Program Profiling

File Systems: Disk management, Name management, Protection.

Parallel Architecture: Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with message passing using MPI.

REFERENCE:

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
2. A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley.
3. R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.

NPTEL Course:

1. High Performance Computing by Prof. Mathew Jacob, IISc Bangalore.

Semester II

MTCE1201: Data Science

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Data Mining Patterns: Cluster Analysis, Anomaly Detection, Association Rules,

Data Mining Sequences:

Text Mining: Text mining Text Clusters

Data Analysis: Simple regression, Multiple Regression, Multivariate Regression Analysis, Robust Regression, Correlation, Clustering.

Data Viualization: R graphics, Plotting, Scatter Plots Bar Charts and Plots 3D graphics

Machine Learning: Data Partitioning Predicting events with machine learning, Supervised and Unsupervised learning.

Reference Books

1. Dan Toomey, R for Data Science, Packit First Edition Publishing 2014 NPTEL/Open Course
2. Hadley Wickham et al R for Data Science Oreilly 2016
3. Richard Cotton Learning R Oreilly 2013

1.

MTCE1202: Software Architecture

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Review of Software Engineering, Various Definitions of Software Architecture, Architecture Documentation: SEI Framework, Module View, Component and Connector View, Deployment View, Pattern-Oriented Software Architecture: Layer, MVC, Pipe-Filter, Publish/Scriber, Presentation Abstraction and Control Patterns, Software Architecture quality Attributes, Evaluating Software Architecture, Architecture Decisions, Architecture Knowledge Management, Technology Architectures.

Reference Books

1. Paul Clements, Documenting Software Architecture, Addison Wesley
2. Fran Buschman Pattern Oriented Software Architecture Vol I

MTCE1203 Software Testing (Elective 3)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Course Contents

Introduction: Principles of testing, Software development life cycle models.

Types of testing: White box testing - Static testing, Structural testing, Black box testing–Requirement based testing, positive and negative testing, boundary value analysis, decision tables, equivalence partitioning, state based or graph based testing, compatibility testing, user documentation testing, domain testing.

Integration testing: top down integration, bottom up integration, bi-directional integration, system integration System and Acceptance testing–functional testing–design/architecture verification, business vertical testing, deployment testing, beta testing, certification standards and testing for compliance;

Non-functional testing: setting up the configuration, coming up with entry/exit criteria, balancing key resources, scalability testing, reliability testing, stress testing, interoperability testing;

Acceptance testing: acceptance criteria, selecting test cases for acceptance testing, executing acceptance tests.

Performance testing: collecting requirement, writing test cases, automating performance test cases, analyzing the performance test results, performance benchmarking, capacity planning.

Regression testing: erforming an initial smoke or sanity test, understanding criteria for selecting the test cases, classifying test cases, methodology for selecting test cases, resetting the test cases for regression testing Test planning, management, execution and reporting.

Test metrics and measurements.

REFERENCE:

1. Srinivasan Desikan, Gopalaswamy Ramesh, “Software Tesing Principles and Practices”, Pearson Education.
2. William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York, 1995.

MTCE1203 Algorithm for Big Data (Elective3)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Algorithms, probability theory.

Course Contents

Intro to Probability Theory, Tail bounds with Applications, Markov Chains and Random Walks.

Randomized Algorithms against an Oblivious Adversary, Pairwise Independence and Universal Hashing, The Streaming Model, Approximate Counting, Approximate Median.

Flajolet Martin-Distinct Sampling, Alon-Mattias-Szegedy Sketch, Bloom Filters, Count-min Sketch, Property Testing Model, Local search and testing connectivity.

Enforce and Test Techique: Biclique and Bipartiteness Testing.

Random Walks and Testing Bipartiteness & Expansion, Regularity Lemma and Testing, Triangle Freeness, Boolean Functions, BLR test for Linearity.

REFERENCE:

1. Probability and Computing: Randomized Algorithms and Probabilistic Analysis, by Mitzenmacher and Upfal.
2. Algorithmic and Analysis Techniques in Property Testing, by Dana Ron.
3. Synopses for Massive Data: Samples, Histograms, Wavelets, Sketches, by Graham Cormode, Minos Garofalakis, Peter J. Haas and Chris Jermaine.

NPTEL Course:

1. Algorithms for Big Data by Prof. John Augustine, IIT Madras.

MTCE1203 Real-Time System (Elective 3)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Programming and Data Structures, Operating Systems, Computer Architecture and Organization, Computer Communication, and Database Systems.

Course Contents

Introduction: What is Real Time System?, Application of Real Time System, A Basic Model of Real Time System, Characteristics of Real Time System, Safety and Relibility, Types of Real-Time Tasks, Timing Constraints, Modelling Timing Constraints.

Real-Time Task Scheduling: Concept, Types of real time task and their characteristics, Task scheduling, Clock-Driven Scheduling, Hybrid Schedulers, Event-driven scheduling, EDF scheduling, Rate monotonic System, Issue associate with RMA, Issue in using RMA in practical situations.

Handling Resource Sharing and Dependencies Among Real-Time Tasks: Resource Sharing Among

Real-time Tasks, Priority Inversion, Priority Inheritance Protocol (PIP), Higher Locker Protocol (HLP), Priority Ceiling Protocol (PCP), Difference types of Priority Inversion under PCP, Important features of PCP, Some issues in Using A Resource Sharing Protocol.

Scheduling Real-Time Tasks in Multiprocessor and Distributed Systems: Multiprocessor task Allocation, Dynamic Allocation of Tasks, Fault Tolerant Scheduling of Tasks, Clocks in Distributed Real Time Systems, Centralized Clock Synchronization, Distributed Clock Synchronization.

Commercial Real-Time Operating Systems: Time Services, Features of Real Time Operating System, Unix as a Real Time Operating System, UNIX-based Real-Time Operating System, Wndows as a Real-Time Operating System, POSIX, A Survey of contemporary Real-Time Operating System, Benchmarking Real-Time System.

Real-Time Communication: Examples of Real-Time Communication in Applications, Basic Concepts, Real-Time Communication in LAN, Soft Real-Time Communication in LAN, Hard Real-Time Communication in LAN, Bounded Access Protocol, Performance Comparison, Real-Time Communication over Internet, Routing, Multicast Routing, Resource Reservation, Traffic Shaping and Policing, Scheduling Mechanism, QoS Models.

Real-Time Databases: Examples applications of Real-Time Databases, Review of Basic Database Concepts, Real-Time Databases, Real-Time Databases Application Design Issues, Characteristics of Temporal Data, Concurrency Control in Real-Time Databases, Commercial Real-Time Databases.

REFERENCE:

1. Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
2. Jane W. Liu, "Real-Time Systems" Pearson Education, 2001.
3. Krishna and Shin, "Real-TIme Systems," Tata McGraw Hill. 1999.

NPTEL Course:

1. Real Time Systems by Prof. Rajib Mall, IIT Kharagpur.

MTCE1203 Cryptography and Network Security (Elective 3)

L:3 T:1 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Introduction: Basic objectives of cryptography, secret-key and public-key cryptography, one-way and trapdoor one-way functions, cryptanalysis, attack models, classical cryptography. Block ciphers: Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis. Stream ciphers: Stream ciphers based on linear feedback shift registers, SEAL, unconditional security. Message digest: Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions. Public-key parameters: Modular arithmetic, gcd, primality testing, Chinese remainder theorem, modular square roots, finite fields. Intractable problems: Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem, known algorithms for solving the intractable problems. Public-key encryption: RSA, Rabin and EIGamal schemes, side channel attacks. Key exchange: Diffie-Hellman and MQV algorithms. Digital signatures: RSA, DAS and NR signature schemes, blind and undeniable signatures. Entity authentication: Passwords, challenge-response algorithms, zero-knowledge protocols. Standards: IEEE, RSA and ISO standards. Network issues: Certification, public-key infrastructure (PKI), secured socket layer (SSL), Kerberos. Advanced topics: Elliptic and hyper-elliptic curve cryptography, number field sieve, lattices and their applications in cryptography, hidden monomial cryptosystems, cryptographically secure random number generators.

Text Books:

1. Cryptography and Network Security, William Stallings, Prentice Hall of India

2. Cryptography and Network Security, Forouzan, Tata McGraw-Hill

3. Network Security: Private Communication in a Public World, Charlie Kaufman, Prentice Hall Series

NPTEL course

Prof. D. Mukhopadhyay, Cryptography and Network Security.

MTCE1204 Introduction to Cognitive Science (Elective 4)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Introduction to Computing**.**

Course Contents

Philosophical Issues (fundamental assumptions underlying differing theories), Cognitive Psychology (experiments revealing computational processes underlying cognition), Neuroscience (understanding at the micro-level; wetware), Computational intelligence (simulation and testing of cognitive models), Linguistics (a prime window into cognition is through language).

Perception: Embodiment; From qualia to representation.

Space, Time and Language: Spatial and Temporal categories.

Categorization and Concepts: Prototype Theory, Objects and Events.

Language: Lexical structure, compositionality, and semantics.

Learning: Developmental models.

Evolution of social convention: Multi-Agent Games, Speech Acts, Diachronic Processes.

REFERENCE:

1. Wilson, Robert A., & Keil, Frank C. (eds.), The MIT Encyclopedia of the Cognitive Sciences (MITECS), MIT Press, 2001 [Primary text; available on Cognet].
2. Bowerman, Melissa and Stephen C. Levinson, Language Acquisition and Conceptual Development, Cambridge University Press 2001.
3. Sternberg, Robert J., Cognitive Psychology, 4th ed., Cengage Learning India, 2008.
4. Gardenfors, Peter, Conceptual Spaces: The Geometry of Thought, MIT Press, 2000, 317 pages.

MTCE1204 Virtual Reality (Elective 4)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Basic maths and exposure to engineering.

Course Contents

Introduction: Course mechanics, Goals and VR definitions, Historical perspective, Birds-eye view(general), Birds-eye view(hardware), Birds-eye view(software), Birds-eye view(sensation and perception).

Geometry of Virtual Worlds: Geometric modeling, Transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll, Axis-angle representations, Quaternions, Converting and multiplying rotations, Homogeneous transforms, The chain of viewing transforms, Eye transforms, Canonical view transform, Viewport transform.

Light and Optics: Three interpretations of light, Refraction, Simple lenses, Diopters, Imaging, properties of lenses, Lens aberrations, Optical system of eyes.

Visual Physiology: Photoreceptors, Sufficient resolution for VR, Light intensity, Eye movements, Eye movement issues for VR, Neuroscience of vision.

Visual Perception: Depth perception, Motion perception, Frame rates and displays.

Tracking Systems: Overview, Orientation tracking, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Filtering, Lighthouse approach.

Visual Rendering: Visual Rendering-Overview, Shading models, Rasterization, Pixel shading, VR-specific problems, Distortion shading, Post-rendering image warp.

Audio: Physics and physiology, Auditory perception, Auditory localization, Rendering, Spatialization and display, Combining other senses.

Interfaces: Interfaces overview, Locomotion, Manipulation, System control, Social interaction, Evaluation of VR Systems.

REFERENCE:

1. http://msl.cs.uiuc.edu/vr/
2. George Mather, Foundations of Sensation and Perception: Psychology Press; 2nd edition, 2009.
3. Peter Shirley, Michael Ashikhmin, and Steve Marschner, Fundamentals of Computer Graphics, A K Peters/CRC Press; 3 edition, 2009.

NPTEL Course:

1. Virtual Reality by Prof. Steven LaValle, IIT Madras.

MTCE104 Mobile Computing (Elective 4)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Java Programming, Operating Systems, Basic knowledge on socket connection.

Course Contents

Introduction to mobile computing, installing of required software and preparing the working environment, creatingyour first Android Application.

Layouts, Views, Resources.

Activities, Intents.

Background tasks, Connecting to the Internet.

Fragments, Preferences.

User Interaction – input, menu items, custom views.

User Experience – themes and styles, material design, adaptive layouts, accessibility, localization, debuggingthe UI.

Storing Data, SQLite database.

Sharing Data, content resolvers and providers, loaders to load data.

Services, background work, alarms, broadcast receivers.

Notification, widgets, transferring data efficiently, publishing app.

Multiple form factors, sensors, Google cloud messaging, monetizing your app.

REFERENCE:

1. Android Programming (Big Nerd Ranch Guide), by Phillips, Stewart, Hardy and Marsicano.
2. Android Programming – Pushing the limits by Hellman.

NPTEL Course:

1. Mobile Computing by Prof. Pushpendra Singh, IIITD.

MTCE104 Storage System (Elective 4)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Operating System.

Course Contents

Introduction: History: computing, networking, storage, Need for storage networking, SAN, NAS, SAN/NAS Convergence, Distributed Storage Systems, Mainframe/proprietary vs. open storage, Storage Industry Organizations and Major Vendors Market, Storage networking strategy (SAN/NAS or Distr storage), Impact of Regulations: existing and new.

Technology: Storage components, Data organization: File vs. Block, Object; Data store; Searchable models, Storage Devices (including fixed content storage devices), File Systems, Volume Managers, RAID systems, Caches, Prefetching.

Network Components: Connectivity: switches, directors, highly available systems, Fibre Channel, 1GE/10GE, Metro-ethernet, Aggregation, Infiniband.

Error Management: Disk Error Mgmt, RAID Error Mgmt, Distr Systems Error Mgmt

Highly available and Disaster-tolerant designs: Ordered writes, Soft updates and Transactions, 2 phase, 3 phase, Paxos commit protocols, Impossibility Results from Distributed Systems, Choose 2 of 3: Availability, Consistency and Partition Tolerance.

Layering and Interfaces in Storage Protocols: SCSI 1/2/3SNIA model.

SAN Components: Fibre Channel, IP-based Storage (iSCSI, FCIP, etc.), Examples, NAS: NFS, CIFS, DAFS

Large Storage Systems: Google FS/BigTable, Cloud/Web-based systems (Amazon S3), FS+DB convergence, Programming models: Hadoop

Archival Systems: Content addressable storage, Backup: serverless, LAN free, LAN Replication issues, Storage Security, Storage Management, Device Management, NAS Management, Virtualization : Virtualization solutions, SAN Management: Storage Provisioning, Storage Migration, SRM.

NPTEL Course:

1. Storage Systems by Dr. K. Gopinath, IISc Bangalore.

MTCE105 Functional Programming (Elective 5)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Introduction to Haskell and the ghci interpreter

Defining functions: guards, pattern matching and recursion

Lists, strings and tuples 4. Types and polymorphim

Higher order functions on lists: map, filter, list comprehension

Computation as rewriting, lazy evaluation and infinite data structures

Conditional polymorphism and type classes

User defined datatypes: lists, queues, trees

Input/output and the ghc compiler

Arrays

Reference Books

MTCE1205 Object-Oriented System (Elective 5)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites:

Course Contents

Review of programming practices and code-reuse; Object model and object-oriented concepts; Object-oriented programming languages and implementation; Object-oriented analyses and design using UML structural, behavioral and architectural modeling; Unified development process, Software reuse design patterns, components and framework; Distributed object computing, interoperability and middle ware standards COM/DCOM and CORBA; Object-oriented database system data model, object definition and query language, object-relational system.

REFERENCE:

1. Object Oriented System Analysis, Sally Shlaer, Prentice Hall PTR.
2. Object Oriented System Analysis and Design using UML, Simon Bennett, McGraw-Hill.

MTCE205 Reinforcement Learning (Elective 5)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Course Contents

Introduction, Bandit algorithms – UCB, PAC, Bandit algorithms –Median Elimination, Policy Gradient, Full RL & MDPs, Full RL & MDPs, Dynamic Programming & TD Methods, Eligibility Traces, Function Approximation, Least Squares Methods, Fitted Q, DQN & Policy Gradient for Full RL, Hierarchical RL, POMDPs.

REFERENECE:

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

NPTEL Course:

1. Reinforcement Learning by Dr. B. Ravindran, IIT Madras.

MTCE1205 Pattern Recognition (Elective 5)

L:3 T:0 P:0 MSE:20 IA:20 ESE:60

Prerequisites: Vector spaces and Linear Algebra, Algorithms, Probability theory, Statistics**.**

Course Contents

Introduction and mathematical preliminaries: What is pattern recognition?, Clustering vs. Classification; Applications; Linear Algebra, vector spaces, probability theory, estimation techniques, Decision Boundaries, Decision region / Metric spaces/ distances.

Classification: Bayes decision rule, Normal Distribution, Error probability, Error rate, Minimum distance classifier, Mahalanobis distance; K-NN Classifier, Linear discriminant functions and Non-linear decision boundaries. Mahalanobis Distance, K-NN Classifier, Fisher's LDA, Single and Multilayer perceptron, training set and test sets, standardization and normalization.

Clustering: Basics of Clustering; similarity/dissimilarity measures, clustering criteria, Different distance functions and similarity measures, Minimum within cluster distance criterion, K-means clustering, single linkage and complete linkage clustering, MST, K-medoids, DBSCAN, Visualization of datasets, existence of unique clusters or no clusters.

Feature selection: Problem statement and Uses, Probabilistic separability based criterion functions, interclass distance based criterion functions, Branch and bound algorithm, sequential forward/backward selection algorithms, (l,r) algorithm. Probabilistic separability based criterion functions, interclass distance based criterion functions.

Feature Extraction: PCA, Kernel PCA.

Recent advances in PR: Structural PR, SVMs, FCM, Soft-computing and Neuro-fuzzy techniques, and real-life examples.

REFERENCE:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. Statistical pattern Recognition; K. Fukunaga; Academic Press, 2000.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.

NPTEL Course:

1. Pattern Recognition by Prof. Sukhendu Das and Prof. C.A. Murthy, IIT Madras.