DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, MIT Manipal

M.Tech. COMPUTER SCIENCE AND ENGINEERING

Program Structure (Applicable to 2019 admission onwards)

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 5152	Computational Methods and Stochastic Processes	4	0	0	4	CSE 5253	Advanced Systems Software	3	1	0	4
	HUM 5151	Research Methodology and Technical Communication	1	0	3	2	CSE 5254	Fundamentals of Quantum Computing	3	1	0	4
	CSE 5151	Advanced Computer Networks	3	1	0	4	CSE ****	Elective I	4	0	0	4
	CSE 5152	Advanced Data Structures and Algorithms	3	1	0	4	CSE ****	Elective II	4	0	0	4
	CSE 5153	Advanced Database Systems	3	1	0	4	CSE ****	Elective III	4	0	0	4
	CSE 5154	High Performance Computing Systems	3	1	0	4	*** ****	Open Elective	3	0	0	3
	CSE 5161	Computing Lab I	0	0	6	2	CSE 5261	Computing Lab II	0	0	6	2
	CSE 5162	Program Lab	0	0	3	1						
		Total	**17**	**4**	**12**	**25**		**Total**	**21**	**2**	**6**	**25**
II	**THIRD AND FOURTH SEMESTER**											
	CSE 6098	Project Work							0	0	0	25
								Total	0	0	0	**25**

PROGRAM ELECTIVES			
CSE 5001	Advanced Computer Graphics	CSE 5007	Embedded Systems
CSE 5002	Algorithmic Foundations of Data Science	CSE 5008	Fundamentals of Theoretical Computer Science
CSE 5003	Object Oriented Systems Design	CSE 5009	Parallel Algorithms
CSE 5004	Logic and Functional Programming	CSE 5010	Natural Language Processing
CSE 5005	Computer Vision and Image Processing	CSE 5011	Web Services
CSE 5006	Pattern Classification	CSE 5012	Advanced Machine Learning

OPEN ELECTIVES			
CSE 5051	Deep Learning	CSE 5052	Software Project Management and Quality Assurance

SEMESTER I

MAT 5152 COMPUTATIONAL METHODS AND STOCHASTIC PROCESSES [4 0 0 4]

Random variables, one and two dimensional random variables, expectation, variance, covariance and correlation coefficient of random variables, uniform distribution, Functions of random variables, Bayesian estimation, credible intervals, Bayesian Hypothesis. Statistics of stochastic processes, Stationarity; Autocorrelation, Power density spectrum. Markov Models, Gaussian mixture models. Data Analysis, Regression, Predicting real value outputs. Optimization Techniques, Mathematical formulation of linear programming problems, Simplex method. Numerical solution to BVP's by finitedifference & finiteelement methods. Solution of parabolic elliptic, hyperbolic PDEs. Linear Algebra, several decompositions and Singular Value decomposition (SVD). Basics of Graph theory, connectivity, spanning tree and traversability. Two person zero sum game theory, non- zero sum game theory. Dominance Method, Graphical Method.

References:

1. A. Papoulis and S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
2. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, 2001, Singapore.
3. Applied Numerical Methods McGraw Hill.
4. HamdyA. Taha – Operations Research McGraw Hill.
5. Frank Harary, Graph Theory, Narosa Publishing House 2001.
6. David C Lay, Linear Algebra and its Applications, Pearson Publications (Third Edition).
7. NarsinghDeo, Graph Theory with Applications to Engg. and Computer Science, PHI Learning Private Ltd

HUM 5151 RESEARCH METHODOLOGY AND TECHNICAL PRESENTATION [1 0 3 2]

Mechanics of Research Methodology: Basic concepts: Types of research, Significance of research, Research framework, Case study method, Experimental method, Sources of data, Data collection using questionnaire, Interviewing, and experimentation. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, need for having a working hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing, Sampling methods- Introduction to various sampling methods and their applications. Data Analysis: Sources of data, Collection of data, Measurement and scaling technique, and Different techniques of Data analysis. Thesis Writing and Journal Publication: thesis writing, journal and conference papers writing, IEEE and Harvard styles of referencing, Effective Presentation, Copyrights, and avoiding plagiarism.

The Lab focusses on enabling students to develop experiments, analyze data, think critically about theory and data and communicate their results and analysis in writing and oral presentation.

References

1. Dr Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004.
3. John W. Creswel, Research Design: Qualitative, Quantitative and Mixed Methods Approaches, SAGE, 2004
4. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
5. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008.
6. Donald R Cooper & Pamela S Schindler, Business Research Methods, McGraw Hill International, 2007.
7. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006
8. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
9. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
10. Cochrain& Cox, Experimental Designs, II Edn. Wiley Publishers, 2006.

CSE 5151 ADVANCED COMPUTER NETWORKS [3 1 0 4]

Unmanned aerial vehicle (uav) networks: Introduction, challenges, key issues, comparative study, UAV features, Multi-UAV network, UAV network topologies, categorization, self-organization in UAV networks, UAV routing protocols, Handoffs in UAV networks. SDN: Benefits, Use cases, Controllers, Policies, Overlays, Automating Cloud via SDN. Supporting Multivendor Ecosystems. Data Center Evolution: Modern Data Center, Monolithic Storage Array, Virtualization, Convergence, the Role of Cloud, Cloud Types, Cloud Drivers. Emerging Data Center Trends, Hyperconverged Infrastructure. Multimedia Networking: Types of Multimedia, Streaming, DASH. CDN, Case Studies. VoIP. Best-Effort Service, Jitter, Best-Effort Networks, QoS Guarantees, Resource Reservation, Call Admission. Optical Networks: Multiplexing, Generations, Switching, Transparency. WDM Network Elements: Optical Line Terminals, Amplifiers, Multiplexers, OADM Architectures. Network Survivability: Basic Concepts, Self-Healing rings, Protection, Resilient Packet Rings, Service Classes.

References:

1. Brian Underdahland Gary Kinghorn, "Software Defined Networking For Dummies", Cisco Special Edition, John Wiley & Sons, Inc., 2015.
2. Scott D. Lowe, James Green, and David Davis, "Building a Modern Data Center: Principles and Strategies of Design", ActualTech Media, USA, 2016.
3. James F. Kurose, Keith W. Ross, "Computer Networking-A Top Down Approach", (6e),Pearson, 2013.
4. Rajiv Ramaswami, Kumar N. Sivarajan, Galen H. Sasaki, "Optical Networks -A Practical Perspective", (3e), Morgan Kaufmann, 2010.

CSE 5152 ADVANCED DATA STRUCTURES AND ALGORITHMS [3 1 0 4]

Amortized Analysis: Aggregate analysis, The Aggregate analysis, The accounting method, The potential method, Dynamic Tables. B-Trees: Basic operations on B-Trees, Deleting a key from a B-Tree. Binomial trees and Binomial heaps: Operations on Binomial heaps. Structure of Fibonacci heaps, Mergeable heap operations, Decreasing a key and deleting a node. The van EmdeRoas Tree: Preliminary approaches, A recursive structure, Disjoint-set operations: Linked-list representation of disjoint sets, Disjoint set forests. Single-Source Shortest Path: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Difference constraints and shortest paths. All-Pairs Shortest Paths: shortest Paths and matrix multiplication, Johnson's algorithm for sparse graphs. Maximum Flow: Flow Networks, The Ford-Fulkerson method, Maximum Bipartite Matching, Multithreaded Algorithms: The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort.

References:
1. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford,"Introduction to Algorithms", (3e), MIT Press, 2009.
2. Cormen Thomas H., Leiserson Charles E, Rivest Ronald L. and Stein Clifford, "Introduction to Algorithms" (2e), Prentice-Hall India, 2001.
3. Baase Sara and Gelder A.V., "Computer Algorithms -Introduction to Design and Analysis", (3e), Pearson Education, 2000
4. Anany Levitin, "Introduction to the Design and Analysis of Algorithms," (3e), Pearson Education, 2011

CSE 5153 ADVANCED DATABASE SYSTEMS [3 1 0 4]

Introduction to Distributed Data Processing, Top-Down Design Process, Distributed Design Issues, Fragmentation, Allocation, Data Directory, Data Access Control, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing Properties of Transactions, Types of Transactions, Serializability Theory, Locking-Based Concurrency Control Algorithm, Timestamp-Based Concurrency Control Algorithm, Dead lock Management, "Relaxed" Concurrency Control, Reliability Concepts, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Consistency of Replicated Databases, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service, NoSQL: Aggregate Data Models, Distribution Models, Consistency, Version Stamps, Map Reduce, Polyglot Persistence.

References:
1. M. Tamer Ozsu, PatrickValduriez, "Principles of Distributed Database Systems", (3e), Springer, 2011.
2. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", (1e), Person Education, Inc., 2013.
3. Saeed K. Rahimi and Frank S, Haug, "Distributed Database Management Systems: A Practical Approach", (1e), John Wiely& Sons, 2010
4. Martin Kleppmann, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems",(1e), O'Reilly Media,Inc., 2017
5. Guy Harrison,"Next Generation Databases: NoSQL, NewSQL and BigData", (1e), Apress, 2015

CSE 5154 HIGH PERFORMANCE COMPUTING SYSTEMS [3 1 0 4]

Introduction to Parallel Computing, Parallel Computer Structures, Handler's classification, Feng's classification, Applications of parallel processing, Classification of pipeline processor, Nonlinear pipelining, Synchronous Parallel Processing, Inter-PE Communications, Interconnection network, Thread level parallelism and multiprocessors, Interconnection networks, Elementary Parallel Algorithms, Various models, Message Passing Programming, Message Passing Libraries, OpenCL Device Architectures, OpenCL Architectures, Heterogeneous Computing, OpenCL Standard, OpenCL Specification, Kernels and OpenCL execution models, Program layout, Memory model, Writing Kernels, Basic OpenCL examples, Thread structure, Work-item and work-group, OpenCL memory model, Example applications, Convolution, CUDA programming basics, CUDA programming model.

References:
1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing," Tata McGraw-Hill India, 2012.
2. John L. Hennessy, David A. Patterson,"Computer Architecture: A Quantitative Approach," (5e), 2014.
3. Michael J Quinn, "Parallel Computing: Theory and Practice", (2e), Tata McGraw Hill, 2002.
4. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," McGraw Hill, 2003.
5. Benedict R. Gaster, Lee Howes, David R, Perhaad Mistry, Dana Schaa, "Heterogeneous Computing with OpenCL," Morgan Kaufmann, 2012.
6. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors,A Hands-on Approach,"(2e),Elsevier, 2012.

CSE 5161 COMPUTING LAB-I [0 0 6 2]

Experiments based on theory covered in Advanced Database Systems, Advanced Computer Networks and High Performance Computing Systems. In the latter half of this lab, students will be working on more complex problems.

CSE 5162 PROGRAM LAB [0 0 3 1]

This lab will provide a platform for students to strengthen their programming skills and enhance their understanding of the application of the various language elements. In the latter half of this lab, students will enhance their problem-solving skills by building solutions to more complex problems.

SEMESTER II

CSE 5253 ADVANCED SYSTEMS SOFTWARE [3 1 0 4]

Introduction, Language Processors, The Structure of a Compiler, Role of the Lexical Analyzer, Input Buffering, Recognition of Tokens, LexicalAnalyzer Generator, Introduction to Syntax Analysis, Writing a Grammar, Top Down and Bottom Up Parsing, LR parsers, Syntax Directed Translation and Definitions, Evaluation order for SDD's, Applications, Intermediate Code Generation, Variants of Syntax Trees, Three Address Code, Type and Declarations, Translation of Expressions, Issues in Design of Code Generator, The Target Language, Basic Blocks, Flow Graphs, Distributed Systems Architecture, Design goals, Types, Styles, Middleware organization, System architectures, Example architectures, Coordination, Clock synchronization, Logical clocks, Mutual exclusion, Election Algorithms, Location systems, Distributed event matching, Gossip-based coordination, Introduction, Data-centric and client-centric consistency models, Replica management, Consistency protocols, Example, Introduction to Fault Tolerance, Process resilience, Reliable client-server communication, Reliable group communication, Distributed commit, Recovery.

References:
1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques and Tools", (2e), Pearson Education, 2010.
2. Andrew S. Tannenbaum, Maarteen Van Steen: "Distributed Systems, Principles and Paradigms", (3e), Version 3.01, 2017.
3. Kenneth C. Louden, "Compiler Construction - Principles and Practice", (1e), Thomson, 2007.
4. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems, Concepts and Design", (4e), Pearson Education, 2009.

CSE 5254 FUNDAMENTALS OF QUANTUM COMPUTING [3 1 0 4]

Introduction, Fundamental concepts. Quantum bits, Quantum computation, Quantum algorithms, Quantum Information, Introduction to Quantum Mechanics, Liner algebra, Postulates of quantum mechanics, Quantum Computation, Quantum circuits, Controlled operations, Measurement, Universal quantum gates, The Quantum Fourier Transform, The quantum Fourier transform, Phase estimation, Applications, Quantum Search Algorithms, Quantum counting, Speeding up the solution of NP-Complete problems, Quantum Information, Classical noise and Markov processes, Quantum Operations, Quantum Error Correction, The Shor code, Theory of quantum error correction, Entropy and Information, Shannon entropy, Basic properties of entropy, Von Neumann entropy, Quantum Information Theory, Distinguishing quantum states and the accessible information, Data compression, Classical information versus noisy quantum channels, Quantum information versus noisy quantum channels, Entanglement as a physical resource, Quantum cryptography.

References:

1. Michael A Nielsen, and Isaac L. Chuang "Quantum Computation & Quantum Information", (10e), Cambridge University Press, 2011.
2. F. Benatti, M. Fannes, R. Floreanini, and D. Petritis, "Quantum Information, Computation and Cryptography" Springer, 2010.
3. Mika Hirvensalo, "Quantum Computing", (2e), Springer-Verlag New York, 2004.
4. JozefGruska, "Quantum Computing", McGraw Hill, 1999.
5. Phillip Kaye, Raymond Laflamme and Michele Mosca, "An Introduction to Quantum Computing", Qxford University Press, 2006.

CSE 5261 COMPUTING LAB II [0 0 6 2]

Experiments based on theory covered in Advanced Systems Software and Object Oriented Systems Design. In the latter half of this lab, students will be working on more complex problems.

SEMESTER III and IV

CSE 6098 PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions. The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work. The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CSE 5001 ADVANCED COMPUTER GRAPHICS [4 0 0 4]

Introduction, Graphics pipeline, Essential Mathematics and the Geometry of 2-Space and 3-Space, Operations on coordinates, polygons, Ray-Casting Renderer, Rasterization, Rendering with a Rasterization API, Performance and Optimization, Textures and Texture Mapping, Variation of Texturing, Building Tangent Vectors from a Parameterization, Codomains for Texture Maps Variations of texturing, Splines and Subdivision Curves and surfaces, Basic polynomial curves, Cubic B-splines, Catmull-Clark Subdivision Surfaces, Physics of light, Fresnel's Law and Polarization, Modelling and measuring light, Standard description of color, Color models, Shaders, Phongshaders, Toon Shading, Introduction to motion, Pose interpolation, Modern Graphics Hardware, Architecture, Parallelism, Programmability, GPUs as Compute Engines.

References:

1. John F. Hughes, Andries Van Dam, Morgan Mc Guire ,David F. Sklar , James D. Foley, Steven K. Feiner and Kurt Akeley, "Computer Graphics: Principles and Practice", (3e), Addison- Wesley Professional, 2013.
2. Edward Angel, "Interactive Computer Graphics A Top Down Approach with WebGL", (7e), Pearson Education, 2014.

CSE 5002 ALGORITHMIC FOUNDATIONS OF DATA SCIENCE [4 0 0 4]

High-Dimensional Space, Best-Fit Subspaces And Singular Value Decomposition (SVD) Random Walks And Markov Chains, Machine Learning: The Perceptron algorithm, Kernel Functions, Generalizing to New Data, Overftting and Uniform Convergence, Regularization: Penalizing Complexity, Online Learning, Online to Batch Conversion, Support-Vector Machines, VC-Dimension, Strong and Weak Learning, Deep Learning,Algorithms For Massive Data Problems: Frequency Moments of Data Streams, Matrix Algorithms using Sampling, Sketches of Documents, Clustering Algorithms, Community Finding and Graph Partitioning, Spectral clustering applied to social networks, Random Graphs . Topic Models, Nonnegative Matrix Factorization, Hidden Markov Models, And Graphical Models, Ranking and Social Choice, Compressed Sensing and Sparse Vectors

References:

1. Avrim Blum, John Hopcroft, and Ravindran Kannan, "Foundations of Data Science", https://www.cs.cornell.edu/jeh/book.pdf
2. Chandrajit Bajaj, "A Mathematical Primer for Computational Data Science", http://www.cs.utexas.edu/~bajaj/math-ds.pdf
3. Steele, Brian, Chandler, John, Reddy, Swarna,"Algorithms forData Science", (1e), Springer, 2016
4. Caathy O'Neil, Rachel Schutt, "Doing Data Science", (1e), O'Reilly, 2013

CSE 5003 OBJECT ORIENTED SYSTEMS DESIGN [4 0 0 4]

The World of the Modern Systems Analyst, Object Oriented Development and the Unified Process, Project Management and the Inception Phase, The Requirements Discipline, Use Cases and Domain Classes, Use case modelling and detailed requirements, Design activities and Environments, Use Case Realization: The Design Discipline within Unified Process Iterations, Few Creational Design Patterns, Few Structural Design Patterns, Few Behavioral Design Patterns, Advanced Topics in Object Oriented Design, Designing the Data Access Layer, Designing the User Interface Layer, Designing System Interfaces, Controls and Security, Software Quality Assurance, System Usability and Measuring User Satisfaction

References:

1. Satzinger, Jackson, Burd, "Object-Oriented Analysis and Design With the unified Process", Thomson, 2007.
2. James W Cooper, "The Design Patterns – Java Companion", 1998.
3. Ali Bahrami, "Object Oriented Systems Development", Tata McGraw-Hill, 2012.
4. James Rumbaugh, Ivar Jacobson, Grady Booch, "The Unified Modeling Language Reference Manual", Addison Wesley, 1999.
5. Tom Pender, "UML Bible", Wiley, 2003.
6. UML 2.0 Superstructure - Final Adopted Specification. Object Management Group, 2003 http: //www.omg.org/docs/ad/03-08-02.pdf.

CSE 5004 LOGIC AND FUNCTIONAL PROGRAMMING [4 0 0 4]

Starting Prolog, Prolog Programs, Data Objects in Prolog: Prolog Terms, Clauses, Predicates, Loading Clauses, Variables, Introduction, Unification, Evaluating Goals, Backtracking, A Summary, Removing Common Variables, A Note on Declarative Programming, Operators, Arithmetic, Equality Operators, Logical Operators, Introduction, Outputting Terms, Inputting Terms, Input and Output using Characters, Outputting and Inputting Characters, Using Characters, Input and Output using Files, File Output: Changing the Current Output Stream, File Input: Changing the Current Input Stream, Reading from Files, Using Files, Introduction, Looping a fixed number of times, Looping until a condition is satisfied, Backtracking with Failure, Preventing Backtracking, Sessions and Scripts, Evaluation, Values, Function, Definitions, Types, Specifications, Booleans, Characters, Enumerations, Tuples, Other types, Type synonyms, Strings, Natural numbers, Induction, The fold function, Haskell numbers, Examples, Church numbers, List notation, List operations, Map and filter, Zip, The fold function, Laws of fold, Examples, Trees.

References:

1. Max Bramer,"Logic Programming with Prolog", (1e), Springer, 2005.
2. Richard Bird, "Introduction to Functional Programming using Haskell" (2e), Prentice Hall Europe, 1998.

CSE 5005 COMPUTER VISION & IMAGE PROCESSING [4 0 0 4]

INTRODUCTION: Introduction to computer vision and its applications, Image formation, Geometric primitives and transformations. IMAGE PROCESSING: Point operators, Linear filtering, More neighbourhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization. FEATURE DETECTION AND MATCHING: Points and patches, Edge Detection methods (Laplacian detectors and Canny edge detector), Harris corner detector, Histogram of Gradients, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC. CAMERA CALIBRATION: Camera models, Stereo vision, Stereo correspondence, Epipolar geometry. TRACKING: Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense motion estimation. 3D CONSTRUCTION: Shape from X, Surface representations, Point-based representations, Model-based reconstruction, Recovering texture maps. OBJECT RECOGNITION: SVM, Face detection and recognition, Bag of words, Deep learning.

References:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications," Springer 2011.
2. David A. Forsyth and Jean Ponce, "Computer Vision: A Modern Approach," PHI learning 2015.
3. Jan Erik Solem, "Programming Computer Vision with Python," O'Reilly, 2012

CSE 5006 PATTERN CLASSIFICATION [4 0 0 4]

Introduction, Definition of Patterns, Paradigms of Pattern Recognition, Representation of Patterns and Classes, Metric and Non Metric Proximity Measures, Feature extraction, Different Approaches to Feature Selection, Nearest Neighbour Classifier and Variants, Algorithm for Nearest Neighbour Classification, Algorithms for Prototype Selection, Bayes Classifier, Decision Trees, Linear Discriminant Functions, Support Vector Machines, Clustering, Clustering Large Data Sets, Combination of Classifiers, Document recognition.

References:

1. Devi V. S., Murty M. N.,"Pattern Recognition: An Introduction," University Press, Hyderabad, 2011.
2. R. O. Duda, P. E. Hart, "Pattern Classification," Wiley, 2000.

CSE 5007 EMBEDDED SYSTEMS [4 0 0 4]

Introduction to Embedded systems: introduction, classification, purpose, domain specific and application specific embedded systems, Basic Embedded Processor/Microcontroller Architecture: ARM Cortex M processor, ARM addressing modes, Instruction set-data transfer, arithmetic and logical, shift and rotate, branch instructions, Functions, Conditional execution, UART, SSI, SPI, Timers and Counters: features of timers T0 and T1, Real-time operating systems (RTOS) based embedded system design: Operating System basics, types, tasks, process and threads, task scheduling, device drivers RTOS programming tools-MICRO C/OS-II AND VxWORKS, Internet of things: Basic concepts, UDP and PCP packets, Web server, UDP communication for WiFi, Bluetooth fundamentals, Bluetooth protocol stack, Client-Server Paradigm Network processor interface, Application layer protocols for Embedded systems, Commercially available RTOS

References:

1. Jonathan W. Valvano., "Embedded systems: Introduction to ARM Cortex-M Microcontrollers" (5e), Createspace Independent publishing platform, June 2014.
2. Jonathan W. Valvano, "Real-Time Operating System for ARM Cortex-M Microcontrollers", (4e), Createspace Independent Publishing Platform, 2019.
3. Jonathan W. Valvano., "Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers" (4e), Createspace Independent Publishing Platform, 2017.
4. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, Janice Mazidi , "ARM Assembly Language Programming & Architecture" (2e), MicroDigitalEd, 2016
5. Shibu K V, "Introduction to Embedded Systems", TataMcGrawHill, 2012.

CSE 5008 FUNDAMENTALS OF THEORETICAL COMPUTER SCIENCE [4 0 0 4]

Introduction, Review of Automata theory, Computability, and Complexity, Mathematical Notations and Terminology, Computability Theory, The Church-Turing Thesis, Turing Machines, Variants of Turing Machines, The definition of Algorithm, Decidability, Decidable Languages, The Halting Problem, Reducibility, The Recursion Theorem, Decidability of Logical Theories, Turing Reducibility, Complexity Theory, Time Complexity, Measuring Complexity, The Class P, The Class NP, NP-completeness, NP-Complete Problems, Space Complexity, Savitch's Theorem, The class PSPACE, PSPACE-completeness, The Classes L and NL, NL-completeness, NL equals coNL, Intractability, Hierarchy theorems, Relativization, Circuit Complexity. The Satisfiability problem, NP-Completeness of the SAT Problem, NP-Completeness of CSAT, Complements of Languages in NP, Problems Solvable in Polynomial

Space, A Problem That Is Complete for PS, Language Classes Based on Randomization, The Complexity of Primality Testing.

References:

1. Michael Sipser, "Introduction to the Theory of Computation", (3e) Thomson, 2014.
2. H.R. Lewis and C.H. Papadimitriou, "Elements of the Theory of Computation", (2e) Prentice-Hall, 1997.
3. Sanjeev Arora and Boaz Barak, "Computational Complexity A Modern Approach", Cambridge University Press, 2009.
4. John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, "Introduction to Automata Theory, Languages, and Computation", (3e), Pearson Education India, 2009.

CSE 5009 PARALLEL ALGORITHMS [4 0 0 4]

Parallel Algorithm Design, Parallel Processing Terminology, Sieve of Eratosthenes, Control parallel and data parallel approach, PRAM model of Parallel Computation, PRAM Algorithms, Parallel Reduction, Tree Traversal, Merging sorted Lists, Graph Coloring, Scaled Speedup and Parallelizability, Amdahl's Law, Gustafson-Barsis's Law, Karp-Flat Metric, Elementary Parallel Algorithms, Parallel Algorithms for Processor Arrays, Parallel Algorithms for Multiprocessors, Parallel Algorithms for Multicomputers, Monte Carlo Methods of Parallel Random Number Generators, Case studies, Solving Linear Systems, Back Substitution, Odd-Even Reduction, Gaussian Elimination, Iterative Methods, Multigrid Methods, Sorting: Lower Bounds on Parallel Sorting, Bitonic Merge sort algorithms, Fundamental design issues in Parallel Computing, Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.

References:

1. Michael J Quinn, "Parallel Computing- Theory and Practice," McGraw-Hill Inc., 2008.
2. Michael J Quinn, "Parallel Programming in C with MPI and OpenMP," McGraw Hill Education Private Limited, 2012.
3. David E. Culler, "Fundamental Design Issues", Computer Science Division, U.C. Berkley, 2012.
   https://slideplayer.com/slide/12297957/

CSE 5010 NATURAL LANGUAGE PROCESSING [4 0 0 4]

Introduction to Natural Language Processing, Morphology and Finite State Transducers, Finite-State Transducers, FSTs for Morphological Parsing, Lexicon-Free FSTs. Words and sentence tokenization, Detecting and Correcting Spelling Errors. N-Grams, Simple(Unsmoothed) N-Grams, Training and Test Data, Smoothing, Interpolation, Backoff. Word classes and Part of Speech Tagging: English Word Classes, Tag-sets for English, Part-of-Speech Tagging, Formal Grammars of English, The Penn Treebank project, Dependency Grammar. Parsing with Context Free Grammars, CKY algorithm. Statistical Parsing: Probabilistic Context-Free Grammars. Dependency Grammar. Semantics predicate argument structure, First order predicate language, Syntax driven semantic analysis, Lexical semantics, Wordnet, Word sense disambiguation, Information retrieval, Introduction to Machine Translation.

References:

1. Daniel Jurafsky& James H. Martin, "Speech and Language Processing", (2e), Pearson, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", (1e), O'Reilly Media, 2009.
3. Akshar Bharati, Rajeev Sangal and Vineet Chaitanya, "Natural Language Processing: A Paninian Perspective", Prentice-Hall of India, New Delhi, 1995.
4. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analysing Text with natural language toolkit", O'Reilly Media, 2009.
5. Chris Manning, HinrichSchutze, "Foundations of Statistical Natural Language Processing",MIT Press, Cambridge, 1999.

CSE 5011 WEB SERVICES [4 0 0 4]

XML Technologies: XML, XML Namespaces, XML Schema Definition Language (XSD), XML Path Language (XPath), Web Technologies: XHTML and HTML5, Javascript, AJAX, Parsing XML with DOM, Web Services Technologies: Web Services Definition Language (WSDL), Simple Object Access Protocol (SOAP), Universal Description, Discovery, and Integration (UDDI), Representational State Transfer (ReST), Creating and Deploying Web Services, Building a Client to Consume Web Service, Semantic Web Services: Web Services to Semantic Web Services, OWL-S, WSDL-S, Service Oriented Architecture (SOA): Realizing the Promise of SOA, Architecture Fundamentals, Composing Services, SOA Security, SOA Governance, Resource Oriented Architecture (ROA): JSON, Resources and Representation, Designing a ReST Service, ReST vs SOAP, Securing a ReST Service, Creating and Consuming ReST Services, Deploy and Manage API on Amazon Web Services (AWS), Microservices: Architecture, Key Benefits, Compare Microservices with SOA, Integration, Building and Consuming Microservices.

References:

1. Joe Fawcett, Liam R. E. Quin and Danny Ayers, "Beginning XML", (5e), Wrox, 2012.
2. Liyang Yu, "Introduction to the Semantic Web and Semantic Web Services", (1e), Taylor & Francis Group, 2007.
3. Michael Rosen, Boris Lublinsky, Kevin T. Smith and Marc J. Balcer, "Applied SOA: Service-Oriented Architecture and Design Strategies", (1e), Wiley, 2008.
4. Leonard Richardson, Mike Amundsen and Sam Ruby, "RESTful Web APIs", (1e), O'Reilly, 2013.
5. Sam Newman, "Building Microservices", (1e), O'Reilly, 2015.

CSE 5012 ADVANCED MACHINE LEARNING [4 0 0 4]

Well-posed learning problems, designing a learning system, concept learning as search, Feature extraction, and feature selection. Metric and Non-Metric Proximity Measures, Modified KNN, Fuzzy KNN,Decision boundaries, Discriminate Functions, univariate and multivariate parameter estimations. Efficient Nearest Neighbour Classifier: Branch and bound, cube, projection, ordered partion, Minimal Distance Classifiers: centroid, condensed. Data organization, Hierachical, Agglomerative, Divisive and partition clustering, Fuzzy K-means, Incremental clustering: Leader, Birch, CF-tree, Model selection for latent variable models and evolutionary algorithms. Entropy and information gain estimation techniques, splitting attribute procedure, Random Forest decision tree representation. Appropriate problems for neural network learning, Multilayer network and the back propagation algorithm for classification of unconstrained document images. KSOM Algorithms, Radial basis functions. Conditional Independence, Parameter estimation, Minimum error-rate classification, Minimum error rate, discriminant functions. Ensemble models.

References:

1. Machine Learning – Tom M. Mitchell, - MGH, 2013.
2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001.
3. EthemAlpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005
4. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009

OPEN ELECTIVES

CSE 5051 DEEP LEARNING [3 0 0 3]

Introduction to neural networks: Humans Versus Computers, Basic Architecture, Training, Practical Issues, Common Neural Architectures, Advanced Topics. Machine learning with shallow neural networks: Binary and Multiclass Models, Autoencoders. Fundamentals of deep networks: What is Deep Learning, Architectural Principles, Building blocks. Training deep neural networks. Gradient-Descent Strategies, Batch Normalization, Acceleration and Compression. Recurrent neural networks (RNN): Architecture, Challenges, Echo State Networks, Long Short Term Memory, Gated Recurrent Units, Applications of RNN. Convolutional neural networks (CNN): Basic Structure, Training a CNN, Case studies of Convolutional Architectures, Visualization and Unsupervised Learning; Autoencoders. Applications of CNN. Advanced topics in deep learning: Attention mechanisms, Generative Adversarial Networks, Competitive Learning.

References:

1. Charu C Aggarwal, "Neural Networks and Deep Learning", Springer International Publishing,2018.
2. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", Oreilly, 2018.
3. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
4. Relevant research papers.

CSE 5052 SOFTWARE PROJECT MANAGEMENT AND QUALITY ASSURANCE [3 0 0 3]

Importance of Software Project Management, Management Principles, Strategic Program Management, Stepwise Project Planning. Project Schedules, Critical Path (CRM) Method, Risk Identification, Cost Schedules. Framework for Management and Control, Collection of Data Project Termination, Managing People, Organizational Behavior, Decision Making, Team Structures, Communication Plans, Case study. Need for Software Quality, Software Quality Assurance, Software Quality factors, Software Development methods, Quality Assurance Activities, Software Maintenance Quality, and Project Management. Staff Training and Certification Corrective and Preventive Actions, Project Process Control, Computerized Tools, Software Quality Metrics, Limitations of Software Metrics, Cost of Software Quality, Classical Quality Cost Model, Extended Model, Application of Cost Model.

References:

1. Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management" (5e), Tata McGraw Hill, New Delhi, 2012.
2. Robert K. Wysocki, "Effective Software Project Management" (4e) – Wiley Publication, 2011.
3. Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India), Fourteenth Reprint 2013.
4. Rajib Mall, "Fundamentals of Software Engineering" PHI Learning PVT. LTD, 4th Edition, 2014
5. Marcelo Marinho et.al; "A Systematic review of Uncertainties in Software Project Management", International Journal of Software Engineering & Applications (IJSEA), Vol.5, No.6, November 2014.
6. Daniel Galin, "Software Quality Assurance", ISBN 0201 70945 7, Pearson Publication, 2009.
7. Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 1997.