MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT of Computer Science and Engineering
M.Tech. Computer Science and Engineering

Semester. I

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CST501	Advanced Data Structures and Algorithms	PC	Theory	3	3	0	0
2	21CST503	Parallel and Distributed Computing	PC	Theory	4	3	0	2
3.	21CST502	Advanced Databases	PC	Theory	3	3	0	0
4.	21CST813	Department Elective – 1	PE	Theory	3	3	0	0
5.	21CST814	Department Elective – 2	PE	Theory	3	3	0	0
6.	21CSP504	Programming Lab-1	PC	Lab	2	0	1	2
				Total	**18**			

Semester. II

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CST507	Research Methodology	PC	Theory	2	2	0	0
2	21CST842	Department Elective – 3	PE	Theory	3	3	0	0
3.	21CST843	Department Elective – 4	PE	Theory	3	3	0	0
4.	21CST844	Department Elective – 5	PE	Theory	3	3	0	0
5.	21CST845	Department Elective – 6	PE	Theory	3	3	0	0
6.	21CSP506	Programming Lab-2	PC	Lab	2	0	1	2
7.	21CSP505	Design Lab /Computing Tools	PC	Lab	2	0	1	2
				Total	**18**			

Semester. III

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CSS603	Technical Documentation and Presentation	PC	---	2	0	1	2
2	21CSP602	Literature Review	PC	---	2	0	1	2
3.	21CSD601	Dissertation – 1	PC	---	8	0	0	16
				Total	**12**			

Semester. IV

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CSD604	Dissertation – 2	PC	---	12	0	0	24
				Total	**12**			

Total Credits: 60

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST501

Course Name : Advanced Data Structures and Algorithms

Credits : 3 L - 3 T - 0 P - 0

Course Type : Core

Prerequisites: None

Course Contents

RAM model – Notations, Recurrence analysis - Master's theorem and its proof - Amortized analysis, Recurrence equations. Advanced Data Structures: B-Trees, Binomial Heaps, Fibonacci Heaps, AVL trees, Red-black trees, B-trees, Splay trees, Interval trees; Disjoint set – union and path compression, Amortized analysis Greedy Algorithms: shortest distance, minimum spanning tree, interval scheduling, interval partitioning; Divide and Conquer: sorting, integer and polynomial multiplication; Dynamic programming: Longest common subsequence. Chain of matrix multiplication, sequence alignment, Bellman Ford Convex hull and Voronoi diagrams, line segments, Optimal polygon triangulation; Primality testing, Integer factorization; Graph algorithms: Matching and Flows; Parallel algorithms: Basic techniques for sorting, searching, merging. Intractability: Independent Set, Vertex Cover, Randomized algorithms, Probabilistic algorithms. Approximate Algorithms: Vertex-cover, set-covering problems, Travelling Salesman problem. Complexity classes - NP-Hard and NP-complete Problems - Cook's theorem NP completeness reductions, undecidability

Recommended Readings

Text Books:-

1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India.

2. AhoA.V , J.D Ulman: Design and analysis of Algorithms, Addison Wesley

3. Brassard : Fundamental of Algorithmics, PHI.

4. Sara Baase: Computer Algorithms: Introduction to Design and Analysis, Pearson Education.

5. Papadimitriou, Steiglitz: Combinatorial Optimization: Algorithms and Complexity, PHI

6. Motwani and Raghavan: Randomized Algorithms, Cambridge University Press

7. Vazirani: Approximation Algorithms, Springer Verlag

8. Joseph Ja'Ja': Introduction to Parallel Algorithms, Addison-Wesley

9. Kleinberg, Tardos: Algorithm Design, Addison Wesley.

10. Dexter Kozen: The Design and Analysis of Algorithms. Springer, 1992

11. SanjoyDasgupta, Christos Papadimitriou, and UmeshVazirani: Algorithms, McGraw Hill.

12. Robert Sedgewick and Kevin Wayne. Algorithms 4/e. Addison-Wesley.

13. Robert Tarjan: Data Structures and Network Algorithms, Society for Industrial and Applied Mathematics

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST503

Course Name : Parallel and Distributed Computing

Credits : 4 L - 3 T - 0 P - 2

Course Type : Core

Prerequisites: Programming in C, Data Structures, Operating Systems, Computer Architecture and Organization, Computer Networks

Course Contents

Parallel Computing, Sequential programs, Parallel Programs, Performance Metrics for Parallel Systems, Effect of Granularity on Performance, Scalability of Parallel Systems, Parallel Programming Platforms, Implicit Parallelism, SIMD & MIMD systems, Clusters, Single-Core and Multi-Core Processors, Physical Organization of Parallel Platforms, Cache Coherence, Interconnection Networks for Parallel Computers. Programming Using the Message-Passing Paradigm - MPI Principles of Message Passing Programming; Building blocks (Sending and Receiving Operations); Communication Library calls; Collective communication and Computation library calls, Programming Shared Address Space Platforms – OpenMP, Directive Parallel Programming; The OpenMP programming Model (Concurrent Tasks, Synchronization Constructs, Data Handling); Open libraries; OpenMP-Environment Variables; Parallel Programs, Matrix Computations, Matrix Vector Multiplication, Matrix- Matrix Multiplication, Solving system of Linear Equations; Parallel Implementation of Sparse Matrix Computations with Vector; Sorting algorithms, Issues in Sorting on Parallel Computers; Bubble Sort and its Variants, Quicksort; Parallelizing Quicksort; Sequential and Parallel Implementation of all-pairs of Shortest Paths Algorithms; Sequential & Parallel Search Algorithms; Depth-First Search Algorithms; Best-First Search Algorithms, Programming on Multi-Core Systems with GPU accelerators An Overview of Brief History of GPUs; An Overview of GPU Programming; An Overview of GPU Memory Hierarchy Features; An Overview of CUDA enabled NVIDIA GPUs, Introduction to CUDA C, Parallel Programming using OpenACC, CUDA APIs, CUDA Libraries for Numerical and Non-Numerical Computations; The OpenCL – Heterogeneous Programming; OpenCL Libraries, The OpenCL Memory Model, Execution Model; Platform and Devices; An Overview of OpenCL API; An Overview of MapReduce, An Overview of MapReduce Programming, An Overview of Hadoop Architecture /Execution (Master/slave, Namenode/Datanode); Hadoop Distributed File System (HDFS), An Overview of Hadoop Components, Hadoop – Control Flow

and Data Flow; An overview of Hive (Distributed Data Warehouse); Hbase (Distributed Column based database, PIG –(Data Flow Language);

Recommended Readings

Text Books:-

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to Parallel Computing, Second Edition Pearson Education – 2007

2. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufman Publishers, Elsevier (2011)

3. Jason Sanders, Edward Kandrot, CUDA By Example – An Introduction to General-Purpose GPU Programming, Addison Wesley (2011)

4. RohitChnadra, Leonardo Dagum, Dave Kohr, DrorMaydan, Jeff McDonald, Ramesh Menon, Parallel Programming in OpenMP, Academic Press (2001)

5. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, (2011), Heterogeneous Computing with OpenCL McGraw-Hill, Inc. Newyork

6. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP McGraw-Hill International Ed (2003)

7. Aru C Murthy, Vinod Kumar Vavilapalli, Doug Eadline, Joseph Niemiec, and Jeff Markham, Apache Hadoop YARN Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison Wesley, 2014

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST502

Course Name : Advances in Databases

Credits : 3 L - 3 T - 0 P - 0

Course Type : Core

Prerequisites: Basic course in Database Management Systems

Course Contents

Query Processing and Optimization – Implementation of Database operations, External Sorting, Size Estimations, Equivalence Rules, Heuristic-based Optimization, Materialized Views, Incremental View Maintenance. Transaction Processing - Concurrency Control Management, Serializability, Two-phase Lock Protocol, Deadlock Prevention and Detection, Timestamp-based Ordering Protocol, Log-based Recovery Management. Modern Database Systems - Database System Architectures, Distributed Database Systems, Parallel Databases, Times in Databases, Multimedia Databases Distributed Databases - Data Storage, Global Catalog, Distributed Transaction Processing, Two-Phase Commit Protocol, Distributed Query Processing.

Recommended Readings

Text Books:-

1. Silberschatz ,Korth, Sudarshan : Database System Concepts, McGraw Hill.

2. Elmasri and Navathe : Fundamentals of Database Systems, 3rd Edition, Addison

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CSP504

Course Name : Programming Lab – 1

Credits : 2 L - 0 T - 1 P - 2

Course Type : Core

Prerequisites:

Course Contents

Programming exercises and experiments in Algorithms Dynamic programming and Approximate Algorithms. Combinatorial algorithms, Randomized algorithms, Graph algorithms: Parallel algorithms: Basic techniques for sorting, searching, merging Programming exercises and experiments in Parallel and Distributed Computing. Parallel processing terminology, Pipelining Vs Data parallelism, multi-threaded architectures. Parallel reduction, Prefix sums, List ranking, preorder tree traversal, Merging two sorted lists Distributed and shared memory, Hadoop and MapReduce Programming exercises and experiments in Advanced Data structure and database. Advanced Lists, Segment Tree,Trie,Binary indexed tree. Self-Balancing BSTs, N-ary Tree. Disjoint Set, Suffix Array and Tree.

Recommended Readings

Text Books:-

1. Cormen, Leiserson, Rivest: Introduction to Algorithms, Prentice Hall of India

2. N. Deo: Graph Theory with Application to Engineering and Computer Science, Prentice-Hall

3. Ghosh, Moona and Gupta, Foundations of parallel processing, Narosa publishing.

4. Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST507

Course Name : Research Methodology

Credits : 2 L - 2 T - 0 P - 0

Course Type : Core

Prerequisites: None

Course Contents

Unit I: Data Structures and Algorithms: Review of Data Structures, and most commonly used algorithms in Computer Science and Engineering – Sorting, DFS/BFS, Pattern Searching. Unit II: Linear Algebra: Vectors - linear vector spaces, linear independence, norms and inner products, Basis and dimension, Matrices, Matrix operations, Inverse of a matrix Orthogonalization, Properties of determinants, Eigenvalues and eigenvectors, SVD and pseudo inverse, KL or hotelling transform. Unit III: Transforms Signals and representation, Convolution, Frequency Transforms, Properties of Fourier Transform, DFT, DCT and FFT, Introduction to wavelets, applications in Computer Science and Engineering Unit III: Probability and Statistics Statistics: Introduction to statistical analysis, hypothesis testing – null and alternate, statistical tests – chi-square, ANOVA, data validation Probability models and axioms, Bayes' rule, discrete and continuous random variables, Probability distributions: normal distribution and properties, conditional, marginal and joint probability distribution, PRNG (pseudo random number generators) - randomness tests, introduction to information theory and cryptography: an Introduction Unit IV: Machine Learning: Linear and non-linear regression, supervised learning – neural network, binary decision diagram, SVM, k-NN, unsupervised learning – Clustering, Hidden Markov Models, Introduction to deep learning. Unit V: Case Studies in Research Domains of CSE.

Recommended Readings

Text Books:-

1. Gilbert Strang: Linear Algebra, MIT Cambridge Press.

2. Sheldon Ross: First Course in Probability, Pearson.

3. Mark Girolami, Simon Rogers: First Course In Machine Learning, CRC Press.

4. Anirban Das Gupta: Probability and Statistics for Machine Learning, Springer.

5. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, second ed, Springer

6. Ian Goodfellow: Deeplearning, MIT Cambridge Press.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CSP506

Course Name : Programming Lab – 2

Credits : 2 L - 1 T - 0 P - 3

Course Type : Elective

Prerequisites: Programming Skills, Data Structures, Computer Networks

Course Contents

1) Programming exercises and experiments in Operating Systems a. Kernel compilation and configuration, kernel modules, system calls and in-line assembly. b. Memory management, process management and scheduling c. Interrupts and interrupt handlers, synchronization etc. 2) Programming exercises and experiments in Advanced Database management systems. a. Cloud Databases: MongoDB/Cassandra etc. b. Transaction Processing: Practice on transaction processing 3) Programming assignments on NetSim and Libalium

Recommended Readings

Text Books:-

1. Stevens, W. R., “Unix Network Programming: Vol. II”, 2nd Ed., Pearson Education

2. Daniel P.Bovet, Marco Cesati, O`Reilly , “Understanding the Linux Kernel” Third Edition, 2005

3. Robert Love , “Linux Kernel Development”, Pearson Education, Third Edition, 2010

4. LAN Trainer user Manual.

5. Lee chao, “Cloud Database Development and Management”, CRC Publisher, 2013

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CSP505

Course Name : Design Lab / Computing Tools

Credits : 2 L - 0 T - 1 P - 2

Course Type : Core

Prerequisites: Students must have prior programming experience in C/C++ or any language; mathematics through differential equations, and numerical analysis

Course Contents

Operating Systems and Unix Environments: features of UNIX/Linux for scientific and technical computing; languages, compilers, debuggers, performance tools, make files, build systems, shell scripting, file management, source code control. Research Documentation and Simple Data Visualization: tools for generating research and code documentation: LATEX, Doxygen, plotting tools. Software Best Practices: software design cycle, regression testing, defensive programming, verification, code coverage Scientific Libraries: availability of common math libraries and usage for scientific computing.High performance Computing (HPC): Tool and techniques.

Recommended Readings

Text Books:-

1. Eric S. Raymond, The Art of Unix Programming, Addison-Wesley 2003

2. Heister, T. and Rebholz, L. G., Introduction to Scientific Computing for Scientists and Engineers. De Gruyter Press, 2015.

3. John Levesque, High Performance Computing: Programming and Applications

Electives Courses for PG-CSE

1.	**21CST802**	Advanced Computer Networks
2.	**21CST824**	Network on Chip
3.	**21CST803**	Advances in Compiler Design
4.	**21CST804**	Android Programming
5.	**21CST806**	Computer Vision
6.	**21CST807**	Cyber Physical Systems
7.	**21CST808**	Data Analytics
8.	**21CST809**	Data Compression
9.	**21CST810**	Data Mining
10.	**21CST812**	Deep Learning
11.	**21CST815**	Distributed Systems
12.	**21CST816**	E-Commerce
13.	**21CST817**	Hardware Software Codesign
14.	**21CST818**	Image Analysis
15.	**21CST819**	Information Retrieval
16.	**21CST820**	Internet of Things
17.	**21CST822**	Natural Language Processing
18.	**21CST823**	Nature Inspired Algorithms
19.	**21CST825**	Network Performance Modelling
20.	**21CST826**	Neural Networks
21.	**21CST827**	Parallel Processing & Algorithms
22.	**21CST828**	Parallelizing Compiler
23.	**21CST830**	Quantum Computing
24.	**21CST831**	Real Time Systems
25.	**21CST832**	Robotics and Control

26.	**21CST801**	5G Technology
27.	**21CST834**	Selected Topics in Operating System
28.	**21CST833**	Selected Topics in Computing
29.	**21CST835**	Social Media Mining
30.	**21CST836**	Social Network Analysis
31.	**21CST837**	Software Project Management
32.	**21CST838**	Software Testing and Validation
33.	**21CST840**	VLSI Algorithms
34.	**21CST841**	Wireless Sensor Networks
35.	**21CST821**	Machine Learning
36.	**21CST829**	Pattern Recognition
37.	**21CST805**	Big Data Analytics
38.	**21CST811**	Data Visualization
39.	**21CST839**	System on Chip
40.	**21CSL760**	Program Analysis

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST802

Course Name : Advanced Computer Networks

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Wireless networking: Bluetooth, 802.11 standards Information theory, bandwidth, multiple access Wireless Terahertz Networks 5G and 6G communication Intelligent Transportation Systems Emerging networking technologies: Host configuration and service discovery principles Future routing architectures IPv6 deployment scenarios and challenges, IPv6 transition/integration Advanced IP multicast, including IPv6 multicast and SSM Software-defined networking Delay-tolerant networking Future home network architectures IP network management and monitoring. Social Networks

Recommended Readings

Text Books:-

1. Tanenbaum A S and Wetherall D J (2010). Computer Networks.

2. Hagen S, (2006). IPv6 Essentials.

3. Recent publications on the relevant fields

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST824

Course Name : Network on Chip

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Computer Architecture, Logic System Design

Course Contents

The Concept of route packet not wires for On-Chip Interconnection Networks, Topology and design architecture of Network-on-Chip, Area and power trade off NoC protocols, Routing and Flow Control mechanism, Verification of Communications in Networks-on-Chips. Application Mapping on Network-on-Chip, Resource Allocation for QoS On-Chip Communication, routing techniques in different 2D/ 3D NoC topology, performance evaluation in terms of throughput, latency, gitter. Signal Integrity and Reliability of Network-on-Chip, Testing of Network-on- Chip Architectures, Test and Fault Tolerance for NoC Infrastructures, Reconfigurable Network-on-Chip Design, Security in NoCs. Energy and Power estimation techniques Network-on-Chips

Recommended Readings

Text Books:-

1. Giovanni De Micheli, Luca Benini, DavideBertozzi, Networks on Chips:Technology and Tools, Morgan Kaufmann, 2006.

2. Fayez Gebali, HaythamElmiligi, Mohamed Watheq El-Kharashi, Networkson- Chips: Theory and Practice, CRC Press, 2017.

3. SudeepPasricha, NikilDutt, On-Chip Communication Architectures: System on Chip Interconnect, Morgan Kaufmann, 2010.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST803

Course Name : Advances in Compiler Design

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Basic course in Compiler Design

Course Contents

Modern Compiler Design – Structure of Compilers for Modern Programming Languages, Cross Compiler, Just-In-Time (JIT) and Adaptive Compilation, Runtime System Architectures. Parser Development - LR Parsers and LR Grammars – Design and Implementation, Parser and Ambiguity, Conflict Resolution, Lex and Yacc Tools. Optimizing Compiler - Control-flow Analysis, Control-flow Graphs, Basic Blocks, Data-flow Analysis Methods, Dependence Analysis, Global Optimizations, Loop Optimizations, Peephole Optimization and Optimal Code Generation, Data Dependence Analysis in Loops, Loop Scheduling.

Recommended Readings

Text Books:-

1. Aho, Lam, Sethi and Ullman: Compilers – Principles, Techniques and Tools, Pearson Education

2. Steven Muchnick : Advanced Compiler Design & Implementation, MorganKaufmann

3. Holub: Compiler Design in C, Prentice Hall India.

4. Keith Cooper and Linda Torczon : Engineering a Compiler, Morgan Kaufmann.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST804

Course Name : Android Programming

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Basics: Review of Java Programming, Setting up and configuring Android Studio setup, Android Emulator Hello Android example, AndroidManifest.xml, R.java file, Activity, Fragment, Layout Manager - Relative Layout, Linear Layout, Table Layout, Grid Layout. Activity, Intent & Fragment: Activity Lifecycle, Activity Example, Intent – implicit and explicit, Intent filters, Fragment Lifecycle, Fragment Example, UI Widgets – buttons (toggle, switch, image), check box; Android Menu: Option Menu, Context Menu, Popup Menu; View. Android Service: lifecycle, example, Data Storage, Shared Preference, SQLite, Content Provider, Android Notification Adding functionality: Multimedia API, Speech API, telephony API, Location API Sensors: Sensor API, Working with WiFi, Working with Camera, Motion Sensor, Position Sensor; Android Graphics App development project.

Recommended Readings

Text Books:-

1. Official Android Website

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST806

Course Name : Computer Vision

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction, Pixels and Filters, Image pyramids and Fourier transform, Hough transform, Edge detection, RANSAC, Feature detectors, Harris, Feature descriptors, Corner detection and matching, 2D transformations, Image homographs, Camera models, camera calibration, radiometry, color, shading, Bag of words, SIFT, SURF, Segmentation, Image indexing and search, Nearest Neighbor Match, Object Recognition, Face recognition, Differential motion: Optical flow, Feature Tracking & Motion Layers, Performance Evaluation

Recommended Readings

Text Books:-

1. Computer Vision: Algorithms and Applications, by Richard Szeliski

2. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce.

3. Computer Vision: Models, Learning, and Inference by, Simon J. D. Prince, Cambridge University Press.

4. Concise Computer Vision: An Introduction Into Theory and Algorithms, by ReinhardKlette, Springer

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST807

Course Name : Cyber Physical Systems

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Characteristics of Cyber-Physical Systems (CPS) Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS CPS physical systems modeling and formalisms: CPS - Platform components - CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks. Principles of Dynamical Systems - Dynamical Systems and Stability, Controller Design Techniques and Performance under Packet drop and Noise CPS implementation issues - From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, and building real-time networks for CPS Safe Reinforcement Learning: Robot motion control, Autonomous Vehicle control Gaussian Process Learning, Smart Grid Demand Response , Building Automation Secure Deployment of CPS: Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on SmartGrids

Recommended Readings

Text Books:-

1. "Introduction to Embedded Systems – A Cyber–Physical Systems Approach" - E. A. Lee, SanjitSeshia

2. “Principles of Cyber-Physical Systems” - Rajeev Alur

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST808

Course Name : Data Analytics

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Fundamentals of Learning, Basic Programming skills,

Course Contents

Introduction: Data Analytics, Big Data, Current landscape of perspectives - Skill sets needed; Statistical Inference-Populations and samples, Statistical modeling, Probability: Probability theory, conditional probability; probability distributions, fitting a model. Basic Analysis Techniques, Basic analysis techniques, Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test Exploratory Data Analysis (EDA) and the Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process, Data Visualization - Basic principles, ideas and tools for data visualization. Python for common data analysis: libraries like NumPy, Pandas matplotlib, and seaborn. Data wrangling and management:Accessing database, CSV, and JSON data, Data cleaning and transformations, APIs and other tools for scraping the Web, Data Management : knowledge of SQL such as MySQL, NoSQL like MongoDB, Cassandra etc. Python for Data cleaning and transformations using Pandas and Sklearn. Mining Social-Network Graphs - Social networks as graphs - Clustering of graphs - Direct discovery of communities in graphs - Partitioning of graphs - Neighborhood properties in graphs.

Recommended Readings

Text Books:-

1. Trevor Hastie Robert Tibshirani Jerome Friedman, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, 2nd Edn, Springer, 2014

2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.

3. Jiawei Han, MichelineKamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011.

4. Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Concepts and Algorithms. Cambridge University Press. 2014.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST809

Course Name : Data Compression

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Object Oriented Analysis and Design

Course Contents

Introduction: Compression techniques, lossless compression, lossy compression, measures of performance, modeling and coding. Mathematical preliminaries - Overview, introduction to information theory, models, physical models, probability models, Markov models. Basic Coding Schemes: Statistical Methods - Shannon-Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding. Arithmetic Coding (Encoding, Decoding, Adaptive Coding). Dictionary Methods - LZ77, LZ78, LZW Algorithms. Case study of lossless compression standards. Lossless Compression standards: zip, gzip, bzip, unix compress, GIF, JBIG. Image and Video Compression: Discrete Cosine Transform, JPEG. Wavelet Methods - Discrete Wavelet Transform, JPEG 2000. Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264. Audio Compression: Digital Audio, WAVE, FLAC, MPEG-1/2 Audio Layers.

Recommended Readings

Text Books:-

1. Khalid Sayood. 2012. Introduction to Data Compression (4th ed.). Elsevier

2. David Salomon, Giovanni Motta. 2010. Handbook of Data Compression. Springer, London

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST810

Course Name : Data Mining

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to data mining: Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining. Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques – Singular Value Decomposition (SVD), Discrete Fourier Transform (DFT), Discrete Wavelet Transform ((DWT), data discretization and concept hierarchy generalization. Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining. Classification and prediction: Definition, decision tree induction, Bayesian classification, rule based classification, classification by backpropagation and support vector machines, associative classification, lazy learners, prediction, accuracy and error measures. Cluster analysis: Definition, clustering algorithms partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis, outlier analysis – density based and distance based. Data mining on complex data and applications: Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.

Recommended Readings

Text Books:-

1. Han, J. and Kamber, M., “Data Mining - Concepts and Techniques”, 3rd Ed., Morgan Kaufmann Series .

2. Ali, A. B. M. S. and Wasimi, S. A., “Data Mining - Methods and Techniques”, Cengage Publishers.

3. Tan, P.N., Steinbach, M. and Kumar, V., “Introduction to Data Mining”, Addison Wesley – Pearson

4. Pujari, A. K., “Data Mining Techniques”, 4th Ed., Sangam Books.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST812

Course Name : Deep Learning

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Course Overview: Introduction to Deep Learning and its Applications. Introduction to Statistical Learning: Multi-Layer Perceptron, Back Propagation, Linear Regression, etc. Convolutional Neural Networks: Convolution, pooling, Activation Functions, Back propagation of CNN, Weights as templates, Translation invariance, Training with shared parameters. CNN Architecture Design and Discussion: AlexNet, VGG, GoogLeNet, ResNet, Capsule Net, etc. Loss Functions and Optimization: Optimization, stochastic gradient descent, dropout, batch normalization, etc. Sequential Modelling: Recurrent and Recursive Nets, RNN, LSTM, GRU, Image captioning, visual question answering, etc. Visualization and Understanding: Visualizing intermediate features and outputs, Saliency maps, Visualizing neurons, Cam-Grad, etc. Generative Models: VariationalAutoencoders, Generative Adversarial Networks like pix2pix, CycleGAN, etc Deep Reinforcement Learning: Reinforcement Learning (RL) Background, Policy gradients, hard attention Q-Learning Deep Learning Applications: Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Retina Net, SSD, etc. Semantic Segmentation: DeepLabV3, PSP Net, etc. Adversarial Attacks on CNN

Recommended Readings

Text Books:-

1. Ian Goodfellow and YoshuaBengio and Aaron Courville, “Deep Learning,” MIT Press.

2. Michael A. Nielsen, “Neural Networks and Deep Learning,” Determination Press, 2015.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST815

Course Name : Distributed Systems

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to Distributed Systems, OS and Advanced OS, various distributed systems, Trends in Distributed System and challenges, Networking: network protocols, point-to-point communication. Introduction – Clocks, events and process states – Synchronizing physical clocks- Logical time and logical clocks – Global states,Limitations, Lamport's logical clock, vector clock, causal ordering, global state, Cuts. Distributed Mutual Exclusion: Lamport, Recart-agrawala, and Maekawa's algorithms; Suzuki-kasami broadcast algorithm, and Raymond's tree based algorithm , Elections algorithms , Transactions and Concurrency Control– Transactions -Nested transactions – Locks – Optimistic concurrency control – Timestamp ordering – Atomic Commit Distributed transactions: two phase commit, three-phase commit, ACID/BASE models Techniques of Inter process Communication: the API for internet protocols – External data representation and Multicast communication, Sun RPC: programming and implementation, Network virtualization: Overlay networks. Case study: MPI Remote Method Invocation And Objects: Remote Invocation – Introduction – Request-reply protocols – Remote procedure call – Remote method invocation. Case study: Java RMI – Group communication – Publish-subscribe systems – Message queues – Shared memory approaches – Distributed objects – Case study: Enterprise Java Beans -from objects to components. Distributed Deadlock Detection: Resource Vs. Communication deadlock, Replication, Strategies to handle deadlock, Ho-Ramamoorthy, Path-Pushing, Edge-Chasing, Diffusion Computation-based algorithms. Agreement Protocols: System model, Classification of agreement problems, Solutions to Byzantine Agreement (BA) problems.Distributed Scheduling: Issues in Load Distribution, Components of a load distribution algorithm, Load Distribution Algorithms, V-system, Sprite, and Condor. Network file systems: design, NFS, AFS (scale), DFS & CIFS (cache control), CODA (redundancy) Google File System (GFS), Hadoop Distributed File System (HDFS)Distributed Shared Memory: Algorithms for implementing DSMs, Memory Coherence, and Coherence Protocols, IVY Process Management: Process Migration: Features,

Mechanism – Threads: Models, Issues, Implementation. Resource Management: Introduction-Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach Recovery: Classification of failures, Synchronous and Asynchronous Check pointing and Recovery. Fault Tolerance: Commit Protocols, Voting Protocols, Failure Resilient Processes. Protection and Security: Access Matrix Model, Implementation of access matrix, Unix, and Amoeba. Case study-Distributed systems

Recommended Readings

Text Books:-

1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems Principles and Paradigm," 2nd Edition, Pearson

2. George Coulouris, Jean Dollinmore, Tim Kindberg, Gordon Blair "Distributed Systems-Concepts and Design," 5th Edition, Pearson

3. M. Singhal& N. Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database and Multiprocessor Operating Systems", Tata McGraw Hill, 2015

4. John Bloomer, "Power Programming with RPC," O'Reilly & Associates, Inc

5. Advanced Programming in the Unix Environment by W. Richard Stevens, Addison-Wesley,

6. Liu M.L., "Distributed Computing, Principles and Applications", Pearson Education,

7. Distributed Systems - An Algorithmic approach by Sukumar Ghosh

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST816

Course Name : E-Commerce

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: knowledge of Digital Market, Basics of Computer Network and security

Course Contents

Introduction: Definition of Electronic Commerce, technology and prospects, incentives for engaging in electronic commerce, needs of E-Commerce, E-Commerce Infrastructure, advantages and disadvantages, Impact of E-commerce on business, E-Commerce Models. Network Infrastructure for E- Commerce. Internet and Intranet based E-commerce: Issues, problems and prospects, Network Infrastructure, Network Access Equipments, Broadband telecommunication. Mobile Commerce: Introduction, Wireless Application Protocol, WAP technology, Mobile Information device. Web Security: Security Issues on web, Importance of Firewall, components of Firewall, Transaction security, Emerging client server, Security Threats, Network Security, Factors to consider in Firewall design, Limitation of Firewalls. Encryption: Encryption techniques, Symmetric Encryption: Keys and data encryption standard, Triple encryption, Secret key encryption; Asymmetric encryption: public and private pair key encryption, Digital Signatures, Virtual Private Network. Customer Service Expectations of the E-commerce Experience, Electronic Payments: Overview, The SET protocol, Payment: Smart card, credit card, magnetic strip card, E-Checks, Credit/Debit card based EPS, online Banking. EDI Application in business, E- Commerce Law, Forms of Agreement, Govt. policies and Agenda

Recommended Readings

Text Books:-

1. Turban, “Electronic Commerce 2004: A Managerial Perspective”, Pearson Education

2. Pete Lohsin , John Vacca “Electronic Commerce”, New Age International

3. Bajaj and Nag, “E-Commerce the cutting edge of Business”, TMH 6

4. Laudon, “E-Commerce: Business, Technology, Society”, Pearson Education

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST817

Course Name : Hardware Software Codesign

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Logic System Design/ Digital Logic Design

Course Contents

Codesign overview, device Modeling and methodologies of system design, Hardware software partitioning and scheduling, Co simulation, synthesis and verifications, Architecture, Interface and reconfiguration, System on chip, Application specific processors (DSP), Codesign tools and case studies

Recommended Readings

Text Books:-

1. A Practical Introduction to Hardware/Software Codesign, Patrick Schaumont,Springer, 2009, ISBN 978-1-4419-5999-7

2. Specification and Design of Embedded Systems Daniel D. Gajski, Frank Vahid, S. Narayan, & J. Gong, Prentice Hall, 1994

3. Hardware / Software Co-Design: Principles and Practice,JStaunstrup and Wayne Wolf, Prentice Hall, 1994.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST818

Course Name : Image Analysis

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Image Preliminaries & Image Processing: Overview, Computer imaging systems, Human visual system, image model, etc. Geometric transformations: Translation, rotation, scaling and shearing. Frequency transformation: Discrete Fourier transform (DFT), fast Fourier transform (FFT), short-time Fourier transform (STFT), Multi-resolution Expansions: Wavelet Transforms in 1-D and 2-D. The Fast Wavelet Transform Wavelet Packets Transform. Feature Extraction and Dimension Reduction Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform, Principal Component Analysis, Linear Discriminant Analysis, Feature Reduction in Input and Feature Spaces. Image Segmentation. Gray-level thresholding, Supervised vs. Unsupervised thresholding, Binarization using Otsu's method, Locally adaptive thresholding, Color-based segmentation, Region oriented segmentation, Use of motion in segmentation, Spatial techniques, Frequency domain techniques. Features Based Image Matching:Scale Space Image Processing, Different Feature descriptors: Key Point Detection, SIFT descriptor SURF descriptor Bag of Visual Words approach, Geometric consistency check, Vocabulary tree Panoramic Imaging, Template Matching, Mono Panorama, Stereo Panorama.

Recommended Readings

Text Books:-

1. J G Proakis and D G Manolakis, "Digital Signal Processing," Pearson, Fourth edition

2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2007.

3. Bishop, Pattern Recognition and Machine Learning

4. Duda, Pattern Classification

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST819

Course Name : Information Retrieval

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to Information Retrieval: The nature of unstructured and semi-structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression: Text encoding: tokenization, stemming, stop words, phrases, index optimization. Index compression: lexicon compression and postings, lists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes, real-world issues. Retrieval Models: Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio. Performance Evaluation: Evaluating search engines. User happiness, precision, recall, F-measure. Creating test collections: kappa measure, interjudge agreement. Text Categorization and Filtering: Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting. Text Clustering: Clustering versus classification. Partitioning methods. k-means clustering. Mixture of Gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents. Advanced Topics: Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval. Web Information Retrieval: Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS, XML and Semantic web.

Recommended Readings

Text Books:-

1. Manning, Raghavan and Schutze, Introduction to Information Retrieval, Cambridge University Press.

2. Baeza-Yates and Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley.

3. SoumenChakrabarti, Mining the Web, Morgan-Kaufmann

4. David A. Groosman, Information Retrieval, Algorithm and Heuristics, Springer

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST820

Course Name : Internet of Things

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Networks, Wireless Communication

Course Contents

Introduction: Internet of Things and Connected Products, IoT paradigm, Smart objects, Goal orientation, Convergence of technologies; Business Aspects of the Internet of Things. Internet and "Things": Layers, Protocols, Packets, Services, Performance parameters of a packet network and applications: Web, Peer-to-peer, Sensor networks, and Multimedia. Hardware and Software: Hardware components, Microcontrollers and Software; Operating Systems. Protocols and Platforms -IoT Communication Protocols, Transport Protocols, Application Protocols; Cloud computing for IoT. Services and Attributes: Data creation, Data gathering and Data dependency; Robustness, Scaling, Privacy, Security, Trust. Designing & Developing IoT applications: Introduction, IoT Design Methodology, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages Application: Implications for the society, IoT case study.

Recommended Readings

Text Books:-

1. The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley

2. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley.

3. Latest research articles

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST822

Course Name : Natural Language Processing

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Data structures and algorithms, and strong programming skills

Course Contents

Introduction to NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field. N-gram Language Models. The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models. Part Of Speech Tagging and Sequence Labeling Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training). Neural Networks and LSTM Introduction to perceptron and backpropagation, LSTM Recurrent Neural Networks Syntactic parsing Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs. Neural shift-reduce dependency parsing Semantic Analysis Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing. Information Extraction (IE) Named entity recognition and relation extraction. IE using sequence labeling. Machine Translation (MT) Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars. Advanced Language Processing Advance language modeling (including LDA), other applications like summarization, question answering

Recommended Readings

Text Books:-

1. Speech and Language Processing: An Introduction to Natural Language

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST823

Course Name : Nature Inspired Algorithms

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Programming languages, Data structures and Algorithms

Course Contents

Introduction to Algorithms, Optimization, Search for optimality, computational intelligence, Nature Inspired solutions and characteristic, Nature inspired Metaheuristics and its brief history, Analysis of Optimization Algorithms, Nature Inspired Algorithms, parameter Tuning and control Constrained and unconstrained optimizations, Random Walks and Optimizations, evolutionary strategies and Evolutionary Algorithms (EA), Simulated Annealing (SA) Algorithm and its behavior, Genetic Algorithms(GA)- genetic operator, parameters, fitness functions, genetic programming and convergence analysis, GA variants, Differential Evolution (DE), various Applications. Swarm Intelligence optimization, Particle Swarm Optimization(PSO) Algorithm, Ant Colony Optimization (ACO) Algorithms, Artificial Bee Colony ACO) optimization algorithms, Cuckoo Search (CS) Algorithms, Intelligent Water Drop Algorithm (IWD), Bat Algorithms(BA), Firefly Algorithms(FA) Framework for self-tuning algorithms, Dealing with constraints, constraints handling, fitness functions ,multi-objective optimization techniques and its applications , Hybrid algorithms, Ways to Hybridize

Recommended Readings

Text Books:-

1. Nature-Inspired Optimization Algorithms – by Xin-She Yang (Author), June 30, 2016

2. Mathematical Foundations of Nature-Inspired Algorithms, Xin-She Yang, Xing-Shi He, Springer; 1st ed. 2019 edition

3. Nature-Inspired Metaheuristic Algorithms: Second Edition, Xin-She Yang, Luniver Press

4. Introduction to Evolutionary Computing, A. E Eiben and J. E. Smith, Second Printing, Springer, 2007

5. Evolutionary Algorithms in Engineering Applications, Editors: DipankarDasgupta and ZbigniewMichalewicz, Springer-Verlag, 1997

6. D. E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson India ,

7. Optimization Techniques and Applications with Examples By Xin-She Yan, wiley publisher

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST825

Course Name : Network Performance Modelling

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to Network Modeling: Network modeling, Computer Network as a discrete event system, Modeling and measurement tools, Network performance metrics – first order and second order metrics, Network capacity, Difference between throughput and capacity Network Calculus: Models for data flows, arrival curves and service curves, Greedy shapers, Basic min-plus and max-plus calculus, min-plus and max-plus systems, Optimal smoothing, FIFO systems and aggregate scheduling, Time varying shapers, Systems with losses, Case studies – (1) Analyzing spanning tree based data forwarding using network calculus, (2) Bound on loss rate Stochastic Scheduling and Resource Allocation: Stochastic scheduling, dynamic resource allocation, Dynamic programming models for stochastic scheduling, Queuing networks – open loop and closed loop networks, Jackson networks, Network fairness – proportional and max-min fairness, Markov process and its application for analyzing network resource allocation and fairness, available bandwidth estimation, Case studies – (1) TCP/IP flow and congestion control, (2) Modeling dynamic routing and scheduling as a queuing network problem, (3) Analysis of IEEE 802.11 channel access using two dimensional Markov process. Network Games: Introduction to game theory, Zero sum games, Nash equilibrium, Pareto optimality, Cooperative and Non-cooperative games, General network games – resource sharing games, routing games, congestion games, Mechanism design, Case studies – (1) Selfish routing in networks and price of anarchy, (2) Oblivious routing, (3) Network resource allocation games Protocol Analysis: Modeling discrete event system using petri-nets, basics of petri nets, stochastic petri nets, queuing petri nets, properties of petri nets, structural analysis of petri nets, Petri net modeling tools – simQPN, Case studies – (1) Wireless channel model using stochastic petri net, (2) Data center network throughput analysis using queuing Petri Nets

Recommended Readings

Text Books:-

1. "Routing, Flow, and Capacity Design in Communication and Computer Networks", MichałPióro, DeepankarMedhi, ISBN: 0125571895, Publisher: Morgan Kaufmann

2. The Network Calculus Book by Jean-Yves Le Boudec and Patrick Thiran is available for free download:http://ica1www.epfl.ch/PS_files/NetCal.htm

3. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" Morgan Kaufman Publishers

4. Dimitri P. Bertsekas and Robert G. Gallager, "Data Networks": Materials are available at http://web.mit.edu/dimitrib/www/datanets.html

5. "Network Optimization: Continuous and Discrete Models", D. Bertsekas

6. Research Publications - will be discussed and distributed time to time

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST826

Course Name : Neural Networks

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential.

Course Contents

Introduction to Neural Architecture, McCulloch-Pitts networks, Learning Rules, Perceptrons, Regression and least mean square algorithm, Multilayer perceptrons, Back propagation: generalized delta rule, limitations, modifications – momentum, variable learning rate, conjugate gradient. Radial-basis function networks, Support vector Machines, Unsupervised learning and self-organization, Boltzmann machines and deep networks, Convolutional networks, Recurrent networks, Associative Memories, Adaptive Resonance Theory, Applications of Neural Networks.

Recommended Readings

Text Books:-

1. Simon Haykin: Neural Networks: A Comprehensive Foundation, Pearson

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST827

Course Name : Parallel Processing & Algorithms

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O. The PRAM Shared-Memory Model, Distributed-Memory or Graph Models, Circuit Model and Physical Realizations PRAM and Basic Algorithms, PRAM Submodels and Assumptions, Data Broadcasting, Semigroup or Fan-In Computation, Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS. Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures. Dynamic interconnection networks.Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock. Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms. Parallel Algorithm Complexity, Asymptotic Complexity, Algorithm Optimality and Efficiency, Complexity Classes, Parallelizable Tasks and the NC Class, Parallel Programming Paradigms, Solving Recurrences Sorting and Selection Network: Design of Sorting Networks, Batcher Sorting Networks, Mesh-Base Architectures: Sorting on a 2D Mesh or Torus, Routing on a 2D Mesh or Torus, Numerical 2D Mesh Algorithms, Low-Diameter Architectures: Hypercubes and Their Algorithms, Sorting and Routing on Hypercubes

Recommended Readings

Text Books:-

1. J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley, 1992.

2. F. T. Leighton, Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes, Morgan Kaufmann Publishers, San Mateo,California,1992

3. BehroozParhami, Introduction to Parallel Processing, Algorithms and Architecture, kluwer academic publishers,2002ed

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST828

Course Name : Parallelizing Compiler

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Basic course in Compiler Design

Course Contents

Introduction – Compilation for parallel machines and automatic detection of parallelism, structure of a parallelizing compiler. Dependence Theory and Practice - Types of dependences, data and control dependencies, dependence analysis, direction vectors, loop carried and loop independent dependences, tests for data dependence and their applicability, construction of data dependence and control dependence graphs. Parallel Code Generation - Automatic extraction of parallelism, representation of iteration spaces of nested loops, loop based transformations such as loop distribution, loop coalescing, loop interchange and cycle shrinking transformation. Interprocedural Analysis and Optimization - aliasing information, summary data flow analysis, interprocedural constant propagation, interprocedural data dependence analysis and parallelization of call statements.

Recommended Readings

Text Books:-

1. Randy Allen, Ken Kennedy: Optimizing compilers for modern architectures. Morgan Kaufmann
2. Steven Muchnick : Advanced Compiler Design & Implementation, Morgan Kaufmann.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST830

Course Name :Quantum Computing

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to quantum computing, Relevant Linear algebra for quantum computing, Postulates of quantum mechanics, Classical computing, Quantum circuits, Quantum Fourier Transform Quantum search algorithms, Physical realization of quantum computers. Quantum noise, Quantum operations, quantum information and quantum channel

Recommended Readings

Text Books:-

1. Pittenger A. O., An Introduction to Quantum Computing Algorithms
2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
3. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST831

Course Name : Real Time Systems

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction : Definition, Typical Real Time Applications; Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency. (7 hours) Real Time Scheduling: Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems. (8 hours) Resources Access Control: Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority-Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects. (8 hours) Multiprocessor System Environment :Multiprocessor and Distributed System Model, Multiprocessor Priority-Ceiling Protocol, Schedulability of Fixed-Priority End-to-End Periodic Tasks, Scheduling Algorithms for End-to-End Periodic Tasks, End-to-End Tasks in Heterogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints. (9 hours) Real Time Communication : Model of Real Time Communication, Soft and Hard RTCommunication systems , Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols forBroadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, Communication in Multicomputer System. An Overview of Real Time Operating Systems and Databases: Features of RTOS, UNIX as RTOS, POSIX Issues, Temporal Consistency, Concurrency Control. (8 hours)

Recommended Readings

Text Books:-

1. Real Time Systems: Theory and Practice – Mall Rajib, Pearson Education, 2009

2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley, 2002.

3. H. Kopetz, "Real time systems: Design Principles for distributed embedded applications", Springer Publications, 2011.

4. Douglass, Real Time UML: Advances in the UML for Real-Time Systems, 3/e, Addison-Wesley, 2004.

5. Awad, Kuusela& Ziegler, Object-Oriented Technology for Real Time Systems: A Practical Approach Using OMT and Fusion, l/e, Pearson Education, 1996.

6. Ward & Mellor, Structured Development for Real-Time Systems, Vol. III: Implementation Modeling Techniques, Prentice Hall, 1986.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST832

Course Name : Robotics and Control

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to robotics-origin of automation, Classification of robots, Rotations and translation of vectors, Transformations and Euler angle representations, Homogeneous transformations, Problems, Trajectory planning, Actuators, Velocity and position sensors. Range, proximity, touch sensors, Control of Robot Manipulators: PD control, Nonlinear Control, Stability, Lyapunov's Direct Method, Adaptive Control, Robot Vision, Image segmentation, Template matching, Polyhedral objects, Shape analysis, Grasping and industrial automation

Recommended Readings

Text Books:-

1. M. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control Wiley (2006)

2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications",

3. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999

4. Nagrath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers

5. K. Ogata, "Modern control engineering", Pearson 2002.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST801

Course Name : 5G TECHNOLOGY

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction and Key Specs of 5G Technologies, Opportunities and Challenges in mmWave MIMO Communication, Channel Models for mmWave MIMO Systems, Hybrid Signal Processing for mmWave MIMO, Digital and AnalogBeamforming, Hybrid RF/ BB Precoder and Combiner Design for mmWave MIMO, Hybrid Transceiver Architectures for mmWave MIMO, Sparse Signal Processing and Channel Estimation for mmWave MIMO, Optimal Design of Beams and Sensing Matrix for Channel Estimation. Overview of Sub 6GHz Multiple Antenna, MIMO and MU-MIMO Technologies, Signal Processing for MIMO Systems, Optimal Power Allocation and Precoding for MIMO, Introduction to 5G Massive MIMO Systems, Key Features of Massive MIMO and Advantages over Point-to-Point and MU-MIMO, Signal Processing Operations for Massive MIMO in UL and DL,Massive MIMO Channel Model– Large/ Small Scale Fading, Properties of Random Vectors and Massive MIMO Analysis, Analysis of Spectral Efficiency in Massive MIMO Systems and Power Scaling, Pilot Design and Channel Estimation in Massive MIMO Systems Transmitter and Receiver Schemes with Imperfect CSI, Spectral Efficiency Analysis of Massive MIMO with Imperfect CSI, Power Scaling in Massive MIMO with Imperfect CSI and Comparison with Perfect CSI, Multi-Cell Massive MIMO Model, Channel Estimation with Pilot Reuse and Pilot Contamination. New Modulation Schemes for 5G- Spatial Modulation (SM), Space Shift Keying (SSK) and Optimal Receiver, Generalized Spatial Modulation (GSM), Spectral Efficiency Comparison of GSM with Conventional V-BLAST. Introduction to Non-Orthogonal Multiple Access (NOMA) Technology, Efficiency of NOMA wrto Conventional Orthogonal Multiple Access (OMA), Fixed NOMA Protocol for UL/ DL – Performance Analysis, Ordered NOMA Protocol and Performance Analysis, Comparison with Fixed NOMA, Optimal Power Allocation for NOMA Systems Overview of Multicarrier Modulation , Introduction to OFDM and MIMO OFDM Transceiver Design, Motivation for Filter Band Multi Carrier (FBMC) Technology in 5G, System Model for FBMC and Signal Processing, Offset QAM (OQAM)

Modulation and Transceiver Design, MIMO-FBMC System – Transmit/ Receive Signal Processing, Introduction to Full-Duplex Technology, Key Features and Advantages of Full Duplex Systems, Linear/ Non-Linear Self-Interference and Analog, Digital Cancellation Stages Introduction to 5G New Radio (NR) Standard, Introduction to 5G NB-IoT Technology, Overview of LTE- Cat M1 and Cat NB 1 Standards/ Systems 5G advanced concepts : Softwareization, virtualization, NFV, VNFV, 5G Slicing and etc Machine Type Communication(MTC) : Use cases and categorization, MTC Requirements, Fundamental techniques for MTC, Massive MTC, Ultra-reliable low-latency MTC, D2D Communication: from 4G to 5G, Radio resource management for mobile broadband D2D, Multi-hop D2D, communications for proximity and emergency services, Multi-operator D2D communication. 5G Radio Access Technologies: Access design principles for multi-user communications, Multi-carrier with filtering, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.

Recommended Readings

Text Books:-

1. Asif Osseiran, Jose F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.

2. Jonathan Rodriquez, "Fundamentals of 5G Mobile Networks", Wiley, 2015

3. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, "5G System Design – Architectural and Functional Considerations and Long Term Research", Wiley, 2018

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST834

Course Name : Selected Topics in Operating System

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Operating Systems

Course Contents

Introduction: Introduction and Background, Power of abstractions, Hardware resources, OS Functionalities, Managing the CPU and Memory. OS-Structure: Commercial OS, Monolithic structure, DOS like-structures. SPIN Approach to extensibility, Logical Protection Domains, Customized OS, Mechanism for events. Exokernel and MicroKernel: Approach to extensibility, Default core services in Exokernel, Secure Binding, Memory Management, L3 MicroKernel Approach, Potentials for Performance Loss, Strikes against Microkernel, Address Space Switches, Thread switches and IPC. Virtualization: Introduction, Platform Virtualization, Hypervisors, Full Virtualization, Para Virtualization. Memory Virtualization: Memory Subsystem recall, Shadow page table. VM oblivious page sharing, Memory Allocation Policies. CPU Virtualization and Device Virtualization: Control and Data transfer in Action, Disk IO Virtualization Protection & Security: Potential Security violations, External versus Internal Security, Policies and Mechanisms, Protection Domain, Design Principles for Secure Systems, Access Matrix Model & its Implementation., Case Studies: Unix Operating system, Hydra Kernel, Amoeba, Andrew.

Recommended Readings

Text Books:-

1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, 9th Edition, Wiley

2. Virtualization Essentials by Matthew Portnoy, Second Edition

3. Advanced Concepts In Operating Systems by Singhal, Tata McGraw-Hill Education

4. Daniel Bovet and Marco Cesati, Understanding the Linux Kernel, 3rd Edition, O'Reilly Media, 2008.

5. https://in.udacity.com/course/advanced-operating-systems--ud189/

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST833

Course Name : Selected Topics in Computing

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Programming in C / Python, Operating Systems, Database Management Systems, Computer Networks, Computer Architecture

Course Contents

Topics will be announced by the Course Instructor at the beginning of the course depending on the emerging and evolving architectures. However, a sample list of topics are given for 2020-21 as below: Cluster and Grid Computing, Cloud Computing Big Data Analytics, Data Science, Data Lakes Internet of Things, 5G and beyond Software Defined Networks, Network Function Virtualization Quantum Computing, Block Chain

Recommended Readings

Text Books:-

1. Request for Comments, Red Books, White Papers

2. Research Papers on various aspects as decided by the Instructor

3. Lecture Notes of the Instructor

4. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Addison-Wesley Professional, 2016

5. Kai Hwang, Min Chen, Big-Data Analytics for Cloud, IoT and Cognitive Computing, Wiley-Blackwell, 2017

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST835

Course Name : Social Media Mining

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Online Social Networks (OSNs): Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data, Social Networks - Basic Structure and Measures, Basics of Text Processing over Social Data, Entity linking and entity resolution for Social data. Characteristics of OSNs: Information Diffusion, Experimental studies over OSNs, Sampling, Fundamentals of Social Data Analytics: Topic Models, Random Walks, Heterogeneous Information Networks Applied Social Data Analytics: Recommendation Systems, Community identification and link prediction. Advanced Topics: Online experiments for Computational Social Science, Big Data Sampling

Recommended Readings

Text Books:-

1. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media

2. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann

3. Charu Aggarwal (ed.), Social Network Data Analytics, Springer

4. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining An Introduction, Cambridge University Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST836

Course Name : Social Network Analysis

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Network Models: Properties of Real-World Networks: Degree Distribution, Clustering Coefficient, Average Path Length. Random Graphs , Small-World Model, Preferential Attachment Model, Modeling of Real-World Networks using Random Graphs, Small-World Model and Preferential Attachment Model Network Measures: Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Centrality, Closeness Centrality, Group Centrality. Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence. Community Analysis: Community Detection, Community Detection Algorithms: Member-Based Community Detection, Group-Based Community Detection. Community Evolution: How Networks Evolve, Community Detection in Evolving Networks. Community Evaluation: Evaluation with Ground Truth, Evaluation without Ground Truth . Recommendation: Classical Recommendation Algorithms: Content-Based Methods, Collaborative Filtering (CF), Extending Individual Recommendation to Groups of Individuals, Recommendation Using Social Context, Evaluating Recommendations: Evaluating Accuracy of Predictions, Evaluating Relevancy of Recommendations Graph Representation Learning, Knowledge Graphs and Meta Paths, Graph Convolutional Networks, Link Prediction, Influence Maximization & Outbreak Detection.

Recommended Readings

Text Books:-

1. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg.

2. Networks: An introduction by Mark Newman.

3. The Development of Social Network Analysis” by Linton C Freeman

4. Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST837

Course Name : Software Project Management

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Software Engineering, Computer Programming (C/Java/Python/C++), Microsoft Excel

Course Contents

Software Project Concepts: Software Project Categorization, Stakeholders, Software project Activities, Practices & Standards, Selecting Process Models (Spiral, Incremental, Prototyping, RAD, Agile). Estimation & Evaluation techniques,Cost Benefit Analysis, Risk Analysis for Project Evaluation, Program management, Project effort and cost estimation; Basis of estimation, Estimation method categorization, SLOC, Function Point Analysis, COCOMO, Putnam's work. Estimation using FP. Project Planning: Stepwise planning, Activity based approach (WBS), Sequencing and Scheduling of Activities, Critical Path Method. Risk Analysis and Management: Risk Identification, Projection, Risk Identification, Projection, Risk Refinement, Risk Monitoring and Management Schedule and Cost Monitoring: Collecting Data & Reporting, Graphical Visualization techniques, Cost Monitoring, Earned Value analysis, Requirements management, Change Control. Contract Management: Types of Contracts, Stages in Contract Placement, Typical Terms of a Contract, Contract Management and Acceptance. Software Configuration Management (SCM), SCM Tools, Project Reviews Testing and Software Reliability, Metrics, ISO and CMMI, Project Scheduling & Tracking, Software Quality Assurance, Software Configuration Management

Recommended Readings

Text Books:-

1. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management", 6th Edition, Tata McGraw Hill, 2017.

2. PankajJalote, Software Project Management in Practice.

3. Roger S. Pressman, Software Engineering

4. Royce, “Software Project Management”, Pearson Education, 1999.

5. Robert K. Wysocki, Effective Software Project Management, Wiley, 2009.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST838

Course Name : Software Testing and Validation

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Software engineering, basic computer programming skills

Course Contents

Testing Environment and Test Processes: Software Testing Environment, Overview of Software Testing Process, Organizing for Testing, Developing the Test Plan, Verification Testing, Analyzing and Reporting Test Results, Acceptance Testing. Levels of Testing, Unit Testing, Integration Testing, Defect Bash Elimination. System Testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Functional and Non-functional system testing, Compliance Testing, Load Testing, Performance Testing and Security Testing. Static and dynamic testing, Black-box or functional testing, Equivalence partitioning, BVA, structural, White box or glass box testing, Mutation Testing, Data flow testing. Test Automation: Software Testing Tools, Software Test Automation, Debugging, Case study.

Recommended Readings

Text Books:-

1. Srinivasan Desikan and Gopalaswamy Ramesh, “Software Testing – Principles and Practices”, Pearson Education

2. A.P. Mathur, Foundations of Software Testing, Pearson publications

3. NareshChauhan , “Software Testing Principles and Practices ” Oxford University Press , New Delhi .

4. Ilene Burnstein, “ Practical Software Testing”, Springer International Edition.

5. RenuRajani, Pradeep Oak, “Software Testing – Effective Methods, Tools and Techniques”, Tata McGraw Hill.

6. William Perry, “Effective Methods of Software Testing”, Third Edition, Wiley Publishing

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST840

Course Name : VLSI Algorithms

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Logic synthesis & verification: Introduction to combinational logic synthesis, Binary Decision Diagram, Hardware models for High-level synthesis. VLSI Algorithms Partitioning: Problem formulation, classification of partitioning algorithms, Group migration algorithms, simulated annealing & evolution, other partitioning algorithms. Placement, floor planning & pin assignment: Problem formulation, simulation base placement algorithms, other placement algorithms, constraint-based floorplanning, floor planning algorithms for mixed block & cell design. General & channel pin assignment. Global Routing: Problem formulation, classification of global routing algorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms, ILP based approaches. Detailed routing: problem formulation, classification of routing algorithms, single layer routing algorithms, two-layer channel routing algorithms, three-layer channel routing algorithms, and switchbox routing algorithms. Over the cell routing & via minimization: two layers over the cell routers, constrained & unconstrained via minimization Compaction: problem formulation, one-dimensional compaction, two dimension-based compaction, hierarchical compaction.

Recommended Readings

Text Books:-

1. NaveedSherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, 2005, Springer International Edition
2. S.H. Gerez, “Algorithms for VLSI Design Automation”, 1999, WILEY Student Edition, John Wiley & Sons (Asia) Pvt. Ltd.
3. ChristophMeinel& Thorsten Theobold, “Algorithms and Data Structures for VLSI Design”, KAP, 2002.
4. Rolf Drechsheler : “Evolutionary Algorithm for VLSI”, Second edition

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST841

Course Name : Wireless Sensor Networks

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction: Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of adhoc/sensor network, driving applications, issues in adhoc wireless networks/sensor network, data dissemination and gathering, Historical Survey of Sensor Networks Basic Architectural Framework:Traditional layered stack, Cross-layer designs, Sensor network architecture, Physical Layer, Basic Components, Hardware Platforms: Motes, Sensor Devices, Types of Sensors, Sensor's Specification MAC Protocols : Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol. Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols. Sensor network security: Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Layer wise attacks in wireless sensor networks, possible solutions for jamming, tampering, black hole attack, flooding attack. Key Distribution and Management, Secure Routing – SPINS, reliability requirements in sensor networks. Programming in WSNs: Challenges and limitations of programming WSNs, Introduction to TinyOS, -Programming in Tiny OS using NesC, Emulator TOSSIM, Open research issues

Recommended Readings

Text Books:-

1. Feng Zhao, Leonidas Guibas, " Wireless Sensor Network", Elsevier, 1st Ed. 2004 (ISBN: 13-978-1-55860-914-3)

2. Kazem, Sohraby, Daniel Minoli, TaiebZnati, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).

3. Raghavendra, Cauligi S, Sivalingam, Krishna M., ZantiTaieb, “Wireless Sensor Network”, Springer 1st Ed. 2004 (ISBN: 978-4020-7883-5).

4. E. H. Callaway, Jr. E. H. Callaway, Wireless Sensor Networks Architecture and Protocols:, CRC Press , 2009

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST821

Course Name : Machine Learning

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus. A basic knowledge of programming (preferably Python) is essential.

Course Contents

Advanced linear Algebra (e.g., SVD). The learning problem – learning versus design, types of learning- supervised, unsupervised, reinforcement and other views of learning.LinearModeling: A least squares approach, linear modeling, making predictions, vector/matrix notation, linear regression, nonlinear response from a linear modelz. Generalization and over-fitting. The Bayesian approach to machine learning: exact posterior, marginal likelihoods Probability based learning: Bayes theorem, Bayesian prediction, conditional independence and factorization, the Naive Bayes model.Error based learning: simple linear regression, multi variable linear regression with gradient descent Logistic regression – gradient descent, non linear transformations the Z space. Similarity based learning: nearest neighbor, k- nearest neighbors, efficient distance computations: the KD trees Information based learning: learning and trees, Classification and regression trees. Ensemble methods, Boosting, Bagging, Random forests. Neural networks – the perceptron, Multilayer perceptron, activation functions, gradient descent, deriving back propagation. Multi-task and transfer learning, Deep-learning. Linear discriminant analysis (LDA), Principal component analysis (PCA)SVM- optimal separation, the margin and support vectors, a constrained optimization problem, kernels – polynomial, radial basis, sigmoid Performance Measures and Evaluation – for categorical targets, prediction scores, multinomial targets, continuous targets. Clustering – the general problem, hierarchical and partitional clustering, K-means clustering.

Recommended Readings

Text Books:-

1. Learning from Data, Yaser S Abu-Mostafa, AML books

2. Machine learning, Marsland, CRC press

3. An Introduction to Machine Learning, KubatMiroslav, Springer

4. Fundamentals of Machine Learning for predictive data analytics, John D Kelleher, MIT Press

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST829

Course Name : Pattern Recognition

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Python is essential.

Course Contents

The classification process: features, training and learning, approaches to classification Non metric methods: Information, Entropy and Impurity, decision tree classifier- ID3, C4.5. Discriminant functions: linear discriminant functions, piece-wise linear discriminant functions, generalized discriminant functions. Statistical pattern recognition: measured data and measurement errors, probability theory, conditional probability and Bayes rule, Naive Bayes classifier, Continuous random variables, The multivariate Gaussian, Covariance matrix and MahalanobisdistanceParametric learning: Bayesian decision theory, discriminant functions and decision boundaries, MAP (Maximum A Posteriori Estimator)Non Parametric learning: Histogram estimator and Parzen windows, k-NN classification, Artificial Neural Networks, Kernel Machines, SVM. Feature extraction and selection: reducing dimensionality, feature selection- Inter/Intra class distance, Feature extraction: Principal component analysis, Linear discriminant analysis.Unsupervised learning: Clustering, K- Means clustering, Fuzzy c-Means clustering, (Agglomerative) Hierarchical clustering Estimating and Comparing Classifiers: No free lunch, Bias and variance trade-off, cross-validation and resampling methods, Measuring classifier performance, Comparing classifiers- ROC curves, McNemar's test, other statistical tests

Recommended Readings

Text Books:-

1. Pattern Classification, Duda Hart, Wiley

2. Pattern Recognition and Classification, Geoff Dougherty, Springer

3. Statistical Pattern Recognition, Andrew R Webb, Wiley

4. Pattern Recognition and Machine Learning, Christopher Bishop, Springer

5. Pattern Recognition and Image Analysis, Earl Gose, Johnsonbaugh, PHI

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST805

Course Name : Big Data Analytics

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Overview of Database Management Systems, Introduction to Big Data, Introduction to distributed file system, Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics. Apache Hadoop & Hadoop Eco-System, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce, Data Serialization. Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, Name-Node, Secondary Name-Node, and Data-Node, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup, SSH & Hadoop Configuration– HDFS Administering, Monitoring & Maintenance. Pig, Pig Latin Language, Hive Introduction, Hive queries. Spark Introduction. Cassandra CQL query language and CQL data model: Key space, Table definition, Column, and Data Types. Mongo DB Cluster analysis, K-means algorithm, Naïve Bayes, Parallel k-means using Hadoop, parallel particle swarm algorithm using MapReduce, case studies on big data mining. Parallel swarm Intelligence.

Recommended Readings

Text Books:-

1. Dan Sulliva ,NoSQL for Mere Mortals 1st Edition., Pearson Publishers, 2014

2. Pramod J. Sadalage, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence 1st Edition, Pearson Publishers,ISBN-13: 978-0321826626, 2017.

3. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies (The MIT Press)

4. John D. Kelleher, Brendan Tierney, Data Science (MIT Press Essential Knowledge series).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST811

Course Name : Data Visualization

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Modern Visualisation tools and techniques, Create multiple versions of digital visualizations using various software packages; Identify appropriate data visualization techniques given particular requirements imposed by the data; Apply appropriate design principles in the creation of presentations and visualizations; Analyse, critique, and revise data visualizations Information overload and issues in decision making Design of visual encoding schemes to improve comprehension of data and their use in decision making Use of Tableau - Data visualization tool for data analysts, scientists, statisticians, etc. to visualize the data and get a clear opinion based on the data analysis, Comparing classifiers- ROC curves, McNemar's test, other statistical tests.

Recommended Readings

Text Books:-

1. A first course Sosulski, K. (2018). Data Visualization Made Simple: Insights into Becoming Visual. New York: Routledge.

2. The Visual Display of Quantitative Information (2nd Edition). E. Tufte. Graphics Press, 2001.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CST839

Course Name : System on Chip

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Transaction-Level Modeling& Electronic System-Level Languages, Hardware Accelerators, Media Instructions, Co-processors, System-Level Design Methodology ,High-Level Synthesis (C-to-RTL), Hardware Synthesis and Architecture Techniques Source-Level Optimizations. Scheduling Resource, Binding and Sharing.

Recommended Readings

Text Books:-

1. De Micheli, editor Special Issue on Hardware/Software Co-design Proceedings of IEEE, Vol 85, No. 3, March 1997

2. D. D. Gajski, F. Vahid, S. Narayan, J. Gong :Specification and Design of Embedded Systems, Prentice Hall, Englewood Cliffs, NJ, 1994

3. J. Staunstrup and W. Wolf, editors: Hardware/Software Co-Design: Principles and Practice Kluwer Academic Publishers, 1997

4. G. DeMicheli, R. Ernst, and W. Wolf, editors, Readings in Hardware/Software Co-Design, Academic Press, 2002.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Computer Science & Engineering

Course Code : 21CSL760

Course Name : Program Analysis

Credits : 3 L - 3 T - 0 P - 0

Course Type : Elective

Prerequisites: None

Course Contents

Introduction to analysis tools: debugging, disassembly, emulators, virtualization Introduction: Program Representation, Syntactic Analysis, Program Semantics, Static and dynamic analysis, Syntactic Analysis, Dataflow Analysis and Abstract Interpretation, Interprocedural analysis, Context-sensitive, Pointer analysis, Call Graph Construction, slicing and profiling, Control Flow Analysis, Dynamic Analysis for Data Race Detection Model Checking, Symbolic execution, Program Repair, Hoare Logic, SMT solvers

Recommended Readings

Text Books:-

1. Pierce, Benjamin C. Types and Programming Languages. MIT Press, 2002.

2. Winskel, Glynn. The Formal Semantics of Programming Languages: An Introduction. MIT Press, 1993.

3. Nielson, Nielson, and Hankin. Principles of Program Analysis. Springer, 2010.

4. Baier, and Katoen. Principles of Model Checking. MIT Press, 2008.

5. Chlipala, Adam. Certified Programming with Dependent Types: A Pragmatic Introduction to the Coq Proof Assistant. MIT Press, 2013.