VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI) MATUNGA, MUMBAI 400 019
(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)
For
Post Graduate Programme Leading to

Masters of Engineering Degree
in
Computer Engineering
(Specialization in Software Engineering)

Department of Computer Engineering and Information Technology,

Implemented from the batch admitted in Academic Year 2022-23

2023

M Tech Computer Engineering
Programme Outcomes

LIST OF PROGRAM OUTCOMES	
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the field of computer engineering and specialized topics in various domains of computer engineering.
PO4	An ability to apply mathematical modeling, algorithms and techniques in respective areas of computer engineering to solve complex engineering problems.
PO5	An ability to design and develop robust, reliable, scalable tools and techniques for knowledge-based systems to enhance lifelong learning.

MTech Computer Engineering
(Specialization in Software Engineering)
Scheme of Instruction and Evaluation
SEMESTER I

Scheme of Instruction					Scheme of Evaluation			
S.No	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	COSE5001S	Computational Methods (PSM)	3-0-0	3	20	20	60	3
2	COSE5011T	Advanced Algorithms (Core-1)	3-1-0	4	20	20	60	3
3	COSE5012S	Software Engineering (Core-2)	3-0-0	3	20	20	60	3
4	COSE502XT	Program Elective -1	3-1-0	4	20	20	60	3
5	COSE503XS	Program Elective - 2	3-0-0	3	20	20	60	3
6	COSE506XT	Open Elective - 1	3-1-0	4	20	20	60	3
7	COSE5071L	Software Engineering (Laboratory - 1)	0-0-2	1	60%CIE		40	-
8	COSE5071L	Cloud Computing (Laboratory - 2)	0-0-2	1	60%CIE		40	-
9	COSE5071L	Cross Platform App Development (Laboratory -3)	0-0-2	1	60%CIE		40	-
10	MTEC081L	Liberal Learning-1	0-0-2	1	60%CIE		40	-
			28	24				

Program Elective -1			Program Elective - 2		
S.No	Course Code	Course Title	S.No	Course Code	Course Title
1.	COSE5021T	Cloud Computing	1.	COSE5031S	Computer Network
2.	COSE5022T	Distributed Systems	2.	COSE5032S	Internet of Things
3.	COSE5023T	Computer Systems Performance Analysis	3.	COSE5033S	GPU Architecture and programming
4.	COSE5024T	Social Network Analysis	4.	COSE5034S	Graph Mining
5.	COSE5025T	Statistical Foundations of Data Science	5.	COSE5035S	Algorithms for Data Science

Open Elective - 1		
S.No	Course Code	Course Title
1.	COSE5061T	Database Management Systems

MTech Computer Engineering
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Scheme of Instruction and Evaluation
SEMESTER II

Scheme of Instruction					Scheme of Evaluation			
S.No	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	COSE5002S	Research Methodology and IPR (Mandatory Learning)	3-0-0	3	20	20	60	3
2	COSE5013T	Software Architecture (Core-3)	3-1-0	4	20	20	60	3
3	COSE5014S	Software Project Management (Core-4)	3-0-0	3	20	20	60	3
4	COSE504XT	Program Elective -3	3-1-0	4	20	20	60	3
5	COSE505XS	Program Elective - 4	3-0-0	3	20	20	60	3
6	COSE506XT	Open Elective - 2	3-1-0	4	20	20	60	3
7	COSE5074L	Software Architecture (Laboratory-4)	0-0-2	1	60%CIE		40	-
8	COSE5075L	DevOps (Laboratory-5)	0-0-2	1	60%CIE		40	-
9	COSE5076L	Big Data Analytics (Laboratory - 6)	0-0-2	1	60%CIE		40	-
10	MTECO082L	Liberal Learning-2	0-0-2	1	60%CIE		40	-
			28	24				

Program Elective -1		
S.No	Course Code	Course Title
1.	COSE5021T	Network administration
2.	COSE5022T	Wireless Communication
3.	COSE5023T	Big Data Analytics

Program Elective - 2		
S.No	Course Code	Course Title
1.	COSE5031S	Network Security
2.	COSE5032S	Blockchain Technology
3.	COSE5033S	Information Retrieval

Open Elective - 2		
S.No	Course Code	Course Title
1.	COSE5065T	Human Computer Interaction
2.	COSE5066T	Machine Learning

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Scheme of Instruction and Evaluation
SEMESTER III

Scheme of Instruction					Scheme of Evaluation
S.No	Course Code	Course Title	L-T-P	Credits	
1	COSE5091D	Skill Based Course (Project Stage -I)	—	5	100%CIE
2	COSE5092D	Skill Based Course (Project Stage -II)	—	5	100%CIE
3	COSE5101S	Self-Learning Course -1	—	1	100% ESE of 3 hours or credit transfer
4	COSE5201S	Self-Learning Course -2	—	1	100% ESE of 3 hours or credit transfer
5	COSE5201MNC	Mandatory Non-Credit Course	—	0	100% ESE of 3 hours or credit transfer
				12	

Scheme of Instruction and Evaluation
SEMESTER IV

Scheme of Instruction					Scheme of Evaluation
S.No	Course Code	Course Title	L-T-P	Credits	
1	COSE5093D	Skill Based Course (Project Stage -III)	—	5	100%CIE
2	COSE5093D	Skill Based Course (Project Stage -IV)	—	7	100%CIE
				12	

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5001S
Course Title	Computational Methods
Course Type	Program Specific Mathematics
Prerequisites: Fundamental of computer science, discrete mathematics and probability theory and statistics.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Analyze mathematical models and methods using proofs. **CO2.** Apply number theory principles for real world problems. **CO3.** Demonstrate counting usage in computer applications. **CO4.** Illustrate probability principles for addressing randomness in the applications. **CO5.** Practice recurrence in real life problems. **CO6.** Design advanced graph theoretic algorithms.	

	Course Contents	Hrs.	CO
1.	**Introduction to proofs:** Propositions, Predicates, Axiomatic Method, Proof by Cases, Proof by Contradiction, Well Ordering Proofs, Propositional Logic, Equivalence and Validity, Algebra of Propositions, Proof by Induction	8	CO1
2.	**Number Theory:** Divisibility, Modular Arithmetic, Multiplicative Inverses, Euler's Theorem, RSA Public Key Encryption	6	CO2
3.	**Counting:** Sums and Asymptotics, Counting Sequences, Counting Subsets, Pigeonhole Principle, Inclusion-Exclusion, Combinatorial Proofs, Generating Functions	6	CO3
4.	**Probability:** Events and Probability Spaces, Conditional Probability, Random Variables, Random Walks	8	CO4
5.	**Recurrences:** Linear Recurrences, Divide-and-Conquer Recurrences	6	CO5
6.	**Directed graphs and Partial Orders:** Vertex Degrees, Walks and Paths, Directed Acyclic Graphs and Scheduling, Partial Orders, Equivalence Relations	6	CO6

Text Books	
1.	Kolman, Bernard, Robert C. Busby, and Sharon Ross. Discrete mathematical structures. Prentice-Hall, Inc., 1995.
2.	Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
Reference Books	
1.	Lehman, Eric, Tom Leighton, and Albert R. Meyer. Mathematics for computer science. Technical report, 2006. Lecture notes, 2010.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5011T
Course Title	Advanced Algorithms
Course Type	Core Subject
Prerequisites: Fundamental of computer science, discrete mathematics and probability theory and statistics.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Analyze algorithms and determine efficiency of algorithm. **CO2.** Design analysis algorithms using the greedy, dynamic programming, and divide and conquer techniques. **CO3.** Design and build solutions for a real world problem using graphs. **CO4.** Prove problems of P, NP, or NP-Complete. **CO5.** Demonstrate geometric algorithms usage in real life problems. **CO6.** Illustrate advanced algorithms techniques for NP Complete problems.	

	Course Contents	Hrs.	CO
1.	**Introduction:** Asymptotic notation, recurrences, amortized analysis	6	CO1
2.	**Algorithm design techniques:** Greedy algorithms, divide-and-conquer algorithms, dynamic programming	8	CO2
3.	**Graph algorithms:** Traversal, topological sort, minimum spanning trees, shortest path,biconnected components, strongly connected components in directed graphs, network flow	8	CO3
4.	**NP-completeness:** Classes P, NP and space complexity, reduction, NP-completeness, examples of NP-complete problems	6	CO4
5.	**Geometric algorithms:** Convex hulls, sweep paradigm, Voronoi diagrams, closest pair, nearest neighbour search.	6	CO5
6.	**Approximation Algorithms:** Approximation algorithms for known NP complete problems	6	CO6

Text Books	
1.	Kleinberg, Jon, and Eva Tardos. Algorithm design. Pearson Education India, 2006.
2.	Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
Reference Books	
1.	Aho, A., J. Hopcroft, and J. Ullman. "The Design and Analysis of Algorithms. Addison and Wesley." Reading, MA (1974).

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5012S
Course Title	Software Engineering
Course Type	Program Elective

Prerequisites: Programming, basics of software engineering

Course Outcomes: At the end of the course student will be able to:

CO1. Illustrate software development process and best practice for software development.

CO2. Demonstrate agile development principles and techniques to manage agile software developments.

CO3. Investigate requirements to generate software requirement document.

CO4. Apply component based design to real life applications.

CO5. Illustrate skills of software testing to projects.

CO6. Estimate cost of the project.

	Course Contents	Hrs.	CO
1.	**Fundamentals of Software Engineering:** software life-cycle process models, industry-standard software engineering tools.	3	CO1
2.	**Agile Methods for Software Development Method:** Extreme Programming (XP), Scrum, Lean, Crystal, Dynamic Systems Development Method and Feature-Driven Development.	8	CO2
3.	**Software Requirements Analysis and Engineering:** Identification of stakeholders, the elicitation and verification of requirements from them, and translation into detailed requirements	6	CO3
4.	**Software Architecture and Component-Based Design:** software design process and it's models; software architectures and design plans; design methods; design state assessment; design quality assurance; and design verification.	8	CO4
5.	**Software Testing and Quality Assurance:** systematic testing of software systems, software verification, symbolic execution, software debugging, quality assurance, measurement and prediction of software reliability.	8	CO5
6.	**Cost Estimation and Measurement:** industry-standard software sizing metrics as Function, Feature, and Object Points and their relationship to the lines-of-code metric.	6	CO6

Text Books	
1.	Roger Pressman. Software Engineering: A Practitioner's Approach (7th. ed.). McGraw-Hill, Inc., USA. 2009.
Reference Books	
1.	Jalote, Pankaj. An integrated approach to software engineering. Springer Science & Business Media, 2012.
2.	Sommerville, Ian. Software Engineering, 9/E. Pearson Education India, 2011.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5061T
Course Title	Database Management Systems
Course Type	Open Elective

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Differentiate various database architectures.
CO2. Design and implement relational databases.
CO3. Execute MongoDB commands to manipulate data.
CO4. Use advanced XML queries on database.
CO5. Apply practices of implementing database security.
CO6. Perform transaction processing and achieve concurrency control.

	Course Contents	Hrs.	CO
1.	**Introduction to Database Management Systems and Enhanced Data Models for Advanced Applications:** Characteristics of database, Database users, Advantages of DBMS, Data Models, Schema and Instances, Three schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment, Centralized and Client / Server Architecture for DBMS. Introduction to Temporal Database and Multimedia Databases.	4	CO1
2.	**Relational-Database Design and SQL:** Functional dependencies, Normalisation forms, Decomposition, Overall database design process. SQL: DDL: Create, Modify, Alter, Drop, View definition, etc.DML: SELECT, INSERT, DELETE, Update, Nested Query, SQL with SET operations: Union, Intersect, Except, etc, Aggregate Functions: Group By, Having, SUM, etc, SQL with Logical operations, Nested and Complex Queries, Join Queries. DCL : GRANT, REVOKE, etc DBA level query. Cursors and Triggers, Procedures and Functions, Partitions, SQL Backup and Recovery.	8	CO2
3.	**Introduction to NoSQL Databases:** Introduction, Design of parallel systems, Parallel query processing. Avenues for parallelism, Array and vector processors. Multiprocessor architecture: taxonomy of parallel architectures, Parallel Query Evaluation. Advanced Transaction Processing Non-relational DBMS: consistency and availability trade-offs, NoSQL DBMS (key-value, document, and graph), MongoDB: CRUD operations.	8	CO3
4.	**XML Databases:** Introduction to XML Documents and Databases, XML schemas, tree structure, and DOM, XML Query.	6	CO4
5.	**Database Security:** Introduction to major database attacks: SQL Injection, DoS/DDoS etc. Encryption and Public Key Infrastructures.	4	CO5

6.	**Transaction Processing and Concurrency Control:** Schedules and serializability, Lock management, Compensation and Databases, Deadlock Handling, Multiple granularity, validation protocols, multi-version protocols, snap shot isolation, predicate locking, Weak Levels of Consistency in Practice.	8	CO6

Text Books	
1.	Elmasri, Navathe. Fundamentals of Database Management systems, Pearson Education, 2008.
2.	Avi Silberschatz, Henry F. Korth, S. Sudarshan. Database System Concepts, Seventh Edition, McGraw-Hill, 2010.
3.	P. Sadalage and M. Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesley, 2012.
Reference Books	
1.	Thomas Connolly and Carolyn Begg, "Database Systems" 3rd Edition, Addison-Wesley, 2005.
2.	V.S. Subrahmanian, "Multimedia database systems", Springer, 1996.

Programme Name	M. Tech. Computer Engineering
Course Code	MTEC081L
Course Title	Indian Knowledge Systems
Course Type	Liberal Learning

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Understand Indic knowledge systems.

CO2. Classify Indian vedas and puranas.

CO3. Justify Indian Science.

	Course Contents	Hrs.	CO
1.	**Introduction:** Introduction to Indic knowledge systems, Introduction to Sanskrit alphabet, root words, structure	2	CO1
2.	**Chaturdasha Vidyasthana:** Introduction to Chaturdasha Vidyasthana – Overview, Veda, Vedangas, Shad Darshana, Smriti Itihasa, Purana	4	CO2
3.	**Indian sciences:** Overview, Mathematics, Astronomy, Engineering, Metals and Mining, Medicine and Surgery, Psychology- mind sciences, Town planning, Ship building, etc	4	CO3
4.	**Leadership:** Leadership lessons from Mahabharata, Ramayana, Lessons from Ramayana, Importance and relevance of Mahabharata and Ramayana	4	CO2
5.	**Evolution of Indian education system:** Overview of Indian education system - Gurukul, Universities, Subjects	4	CO2, CO3
6.	**Revision:** Revision - open discussion - paper work, Revision - wrap up - open discussion - paper work	2	CO1, CO2, CO3

Text Books	
1.	Introduction to Indian knowledge Systems - Concepts and Applications
2.	Mahabharata Unravelled: Lesser Known facets of a well-known history, Ami Ganatra.
Reference Books	
1.	Educational Heritage of India, Sahana Singh.
2.	A beautiful tree, Dharmapal.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5021T
Course Title	Cloud Computing
Course Type	Program Elective
Prerequisites: Operating system	
Course Outcomes: At the end of the course student will be able to: **CO1.** Describe cloud computing concepts, architecture, deployment model and other cloud terminologies **CO2.** Use various aspects of SLA, workout cloud economics. **CO3.** Apply security features of cloud. **CO4.** Distinguish various special purpose cloud. **CO5.** Use and Create private cloud. **CO6.** Design solution using cloud services.	

	Course Contents	Hrs.	CO
1.	**Introduction:** Cloud Computing – Overview, Cloud Computing – Introduction, Evolution of Cloud Computing, Cloud Computing Architecture, Cloud Architecture - Deployment Models, , Virtualization, XML Basics, Web Services, Service Oriented Architecture	6	CO1
2.	**Service Level Agreement (SLA):** SLA – Tutorial (problems), Economics, Economics Tutorial (problems), Managing Data, Introduction to Map Reduce, Map Reduce – Tutorial (problem), Resource Management in cloud	8	CO2
3.	**Openstack Cloud:** Detail Study of openstack cloud, Deployment/ implementation of Openstack cloud as private cloud, OpenStack Major Components, Architecture of Openstack, Openstack Work Flow, Nova scheduler filtering, OpenStack Storage Concepts Study of other services	8	CO5
4.	**Cloud Types:** Broker for Cloud Marketplace, Fog Computing, Use Case Geospatial Cloud, Green Cloud, Sensor Cloud Computing, IoT Cloud	4	CO4
5.	**Cloud Security:** Security - Basic Components, Security Attacks, Classes of Threats, Policies and Mechanisms, Goals of Security, Trust and Assumptions, Types of Mechanisms, Assurance, Operational Issues, Passive and Active Attacks, Security Services.	8	CO3
6.	**Cloud Platforms study:** Case study of public cloud like AWS, Microsoft Azure, Google cloud GCP, Study and use of various services. Cloud Migration, Docker container, Serverless Computing, Dew computing	6	CO6

Text Books	
1.	Arshdeep Bahga , Vijay Madisetti, Cloud Computing: A Hands-On Approach. Universities Press.
Reference Books	
1.	Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. Mastering cloud computing: foundations and applications programming. Newnes, 2013.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5022T
Course Title	Distributed Systems
Course Type	Program Elective
Prerequisites: Operating Systems, Computer Networks.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Illustrate fundamental concepts of distributed systems. **CO2.** Demonstrate synchronization principles for real world problems in distributed systems. **CO3.** Distinguish different middle-ware technologies in computer distributed applications. **CO4.** Examine shared data operations and replication in the distributed applications. **CO5.** Inspect distributed systems with case studies. **CO6.** Design advanced graph theoretic algorithms.	

	Course Contents	Hrs.	CO
1.	**Foundations:** Examples of distributed systems, Architectural models, Network principles, Multi-cast communication, Network virtualization, Message passing interface (MPI), Request-reply protocols, Remote procedure call (RPC), Remote method invocation (RMI), group communication, publish-subscribe systems, message queue systems, shared memory–based approaches.	9	CO1
2.	**Synchronization and Coordination of Distributed Systems:** Clocks, events and process states, Synchronizing physical clocks, Logical time and logical clocks, Global states, Distributed mutual exclusion, Elections, Coordination and agreement in group communication, Consensus and related problems	8	CO2
3.	**Middle-ware Components:** Distributed objects, CORBA, Distributed components, Enterprise JavaBeans and Fractal, Web services, Coordination of web services, Peer-to-peer middleware, Routing overlays, Overlay case studies: Pastry, Tapestry	6	CO3
4.	**Distributed Shared Data:** Distributed mutual exclusion, Elections, Coordination and agreement in group communication, Consensus, Transactions, Nested transactions, Locks, Optimistic concurrency control, Timestamp ordering, Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery, System model and the role of group communication, Fault-tolerant services, Case studies of highly available services: The gossip architecture, Bayou and Coda, Transactions with replicated data	9	CO4

5.	**Distributed Systems:** Overview of security techniques, Case studies: Needham–Schroeder, Kerberos, TLS, 802.11 WiFi, File service architecture, Case study: Sun Network File System, Case study: The Andrew File System, Name services and the Domain Name System, Directory services, Case study: The Global Name Service, Case study: The X.500 Directory Service	6	CO5
6.	**Designing Distribute Systems:** Introducing the case study: Google, Overall architecture and design philosophy, Underlying communication paradigms, Data storage and coordination services, Distributed computation services	3	CO6

Text Books	
1.	George Coulouris, Jean Dollimore, and Tim Kindberg, " Distributed Systems Concepts and Design", 5th ed., Pearson Education, 2011.
2.	Ghosh, Sukumar. Distributed systems: an algorithmic approach. Chapman and Hall/CRC; 2nd edition 2014.
Reference Books	
1.	Van Steen, Maarten, and Andrew S. Tanenbaum. Distributed systems. Leiden, The Netherlands: Maarten van Steen, 2017.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5023T
Course Title	Computer Systems Performance Analysis
Course Type	Program Elective

Prerequisites: Operating Systems, Computer Networks, and Probability and Statistics.

Course Outcomes: At the end of the course student will be able to:

CO1. Evaluate the performance of the various computer systems and networks, mistakes commonly observed in performance evaluation projects and a proper methodology to avoid them.

CO2. Illustrate performance metrics and analyze them mathematically, analytically or through simulation.

CO3. Illustrate the application of probability functions and distributions for computer systems.

CO4. Design mathematical models using Queuing Networks models and use programming languages to simulate and evaluate the performance of various computer systems within or outside the network.

CO5. Evaluate the performance of network systems by using various queuing models.

CO6. Analyze the performance evaluation of various protocols, algorithm in an network environment.

	Course Contents	Hrs.	CO
1.	**Overview of Performance Evaluation:** Introduction, common mistakes and how to avoid them, selection of techniques and metrics.	10	CO1
2.	**Measurement Techniques and Tools:** Types of workloads, the art of workload selection, workload characterization and techniques, monitors, program-execution monitors and accounting logs, capacity planning and bench-marking, the art of data presentation.	10	CO2
3.	**Probability Theory and use for Evaluation:** Introduction to probability refresher, conditional probability, total probability, discrete and continuous random variables, common distributions, probability generating functions(pgf) and Laplace transforms (lst), numerous examples from computer networking, Commonly used distributions.	6	CO3
4.	**Queuing Theory :** Queuing models, little theorem application, stochastic processes, Markov chain formulation, discrete time and continuous time markov chains (dtmc, ctmc), MMD, Operational laws.	4	CO4

5.	**Queuing System Models and Application:** Queuing system m/m/1, m/m/1/k, m/m/s/, m/m/y queue analysis m-server case. Multidimensional markov chain application in circuit switching/g/1 queue, generalization of m/g/1 theory application to atm, embedding instants in the m/g/1 theory m/g/1 with geometrically distributed messages. chain embedded to cell transmission, message transmission completion. queue balance equation, finite buffer case, mean value analysis.	6	CO5
6.	**Network Analysis:** Local area Network analysis, standard comment based analysis, contention based protocols, demand assignment protocols, nodes in packet switches networks, performance analysis of data link layer, Network layer. Traffic control and congestion in ATM networks, TCP/IP Traffic control.	3	CO6

Text Books	
1.	Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling", Wiley-Interscience, 1991.
Reference Books	
1.	K.S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2001.
2.	Ross, Sheldon M. Introduction to probability models. Academic press, 2014.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5024T
Course Title	Social Network Analysis
Course Type	Program Elective

Prerequisites: Analysis of Algorithm, Computer Networks, Data Mining.

Course Outcomes: At the end of the course student will be able to:

CO1. Illustrate sociology and anthropology used the ideas of culture and cultural formation concepts of Social Network Analysis.

CO2. Demonstrate statistical properties for real world problems in Social Network Analysis.

CO3. Distinguish different edge classification techniques and use in the application.

CO4. Examine shared data operations and replication in the distributed applications.

CO5. Inspect data mining in Social Network Analysis with case studies.

CO6. Design advanced graph theoretic algorithms.

	Course Contents	Hrs.	CO
1.	**Foundations:** Introduction to new science of networks; Networks examples; Sociometry, small groups, and communities; Cliques, roles, and matrices; Space and distance; Dynamics and social change	6	CO1
2.	**Statistical Properties of Social Network:** Graph concepts and properties; static and dynamic properties of social graphs; RandomWalk based Proximity Measures; other proximity measures; Graph-theoretic Measures for Semi-supervised Learning; Algorithms for computing the proximity measures; Applications using random walks approach.	8	CO2
3.	**Community Discovery in Social Networks:** Defining communities; Core Methods: Quality Functions, Kernighan-Lin(KL) algorithm, Agglomerative/Divisive Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering; Community Discovery in Dynamic Networks, Heterogeneous Networks, Directed Networks.	6	CO3
4.	**Node Classification in Social Networks:** The Node Classification Problem; Problem Formulation; Local Classifiers, Random Walk based classifier, Node Classification to Large Social Networks, Basic Methods, Second-order Methods, Map-Reduce, Dissimilarity in Labels, Edge Labeling, Label Summarization.	6	CO4
5.	**Data Mining in Social Media:** Data Representation, Event Maps, Social Networking Sites: Illustrative Examples, Blogosphere: Illustrative Examples.	6	CO5
6.	**Visualizing Social Network:** Visual Images, MDS and SVD to explore data, Exploratory Research, Validating a Model, Structural Visualization, Semantic and Temporal Visualization, Statistical Visualization	6	CO6

Text Books

1. Charu C. Aggarwal, "Social Network Data Analytics" Springer New York, NY, 2011.
2. Carrington, P., Scott, J., Wasserman, S. (Eds.). Models and Methods in Social Network Analysis (Structural Analysis in the Social Sciences). Cambridge: Cambridge University Press, 2005.

Reference Books

1. Xiaoming Fu, Jar-Der Luo, Margarete Boos. Social Network Analysis Interdisciplinary Approaches and Case Studies.CRC Press, 2020.
2. Carrington, Peter J., John Scott, and Stanley Wasserman, eds. Models and methods in social network analysis. Vol. 28. Cambridge university press, 2005.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5025T
Course Title	Statistical Foundations of Data Science
Course Type	Program Elective

Prerequisites: probability theory, data mining.

Course Outcomes: At the end of the course student will be able to:

CO1. Describe big data and its Dimensionality.
CO2. Illustrate regression analysis for Big Data.
CO3. Define Regularization of parameters.
CO4. Design feature screening for the applications.
CO5. Understand supervised and unsupervised learning principals for data.
CO6. Compare Openflow controllers and switches with other enterprise networks.

	Course Contents	Hrs.	CO
1.	**Rise of Big Data and Dimensionality:** Impact of Big Data, Impact of Dimensionality, Aims of High-dimensional statistical learning, Aims of Big Data	6	CO1
2.	**Multiple and Nonparametric Regression:** Multiple Linear Regression, Model Building and Basis Expansions, Ridge Regression, Reproducing Kernel Regression.	6	CO2
3.	**Penalized Least Squares:** Best subset and L_0 penalty, Folded-concave Penalized Least Squares, Lasso and L_1-regularization, Numerical Algorithms, Regularization parameters, Refitted Cross-validation, Extensions to Nonparametric Modeling, Generalized Linear Models, Variable Selection via Penalized Likelihod, Numerical Algorithms, Statistical Properties.	8	CO3
4.	**Feature Screening:** Correlation Screening, Generalized and Rank Correlation Screeing, Nonparametric Screening, Sure Screening and False Selection	6	CO4, CO6
5.	**Supervised and Unsupervised Learning:** Model-based Classifiers, Kernel Density Classifiers and Naive Bayes, Nearest Neighbor Classifiers, Classification Trees and Ensemble Classifiers, Support Vector Machine, Sparsier classifiers, Sparse Discriminant Analysis, Sparse Additive Classifiers, Cluster Analysis, Variable Selection in Clustering, Choice of Number of Clusters, Sparse PCA.	10	CO5
6.	**Covariance Regularization and Graphical Models:** Sparse Covariance Matrix Estimation, Robust Covariance Inputs, Sparse Precision Matrix and Graphical Models, Latent Gaussian Graphical Models	8	CO6

Text Books

1. Fan, J., Li, R., Zhang, C.-H., and Zou, H. Statistical Foundations of Data Science. CRC Press, 2020.
2. James, G., Witten, D., Hastie, T.J., Tibshirani, R. and Friedman, J. An Introduction to Statistical Learning with Applications in R . Springer, New York 2013.
3. Hastie, T.J., Tibshirani, R. and Friedman, J. The elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd ed). Springer, New York, 2009.

Reference Books

1. Buehlmann, P. and van de Geer, S. Statistics for High-Dimensional Data: Methods, Theory and Applications. Springer, New York, 2011.
2. Hastie, T., Tibshirani, R., and Wainwright, M. Statistical learning with sparsity. CRC press, New York, 2015.
3. Wainwright, M. J. . High-dimensional statistics: A non-asymptotic viewpoint. Cambridge University Press, 2019.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5031S
Course Title	Computer Network Design
Course Type	Program Elective

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Apply networking tools and techniques to design computer network.
CO2. Evaluate Transport Layer protocols for Quality of Service (QoS).
CO3. Examine Network Layer services and Protocols.
CO4. Recommend Application Protocols as per need of application.
CO5. Categorize various network security flaws.
CO6. Design and deploy computer network as per customer requirement.

	Course Contents	Hrs.	CO
1.	**Computer Network Design Foundation:** Introduction to Networking: Comparison between OSI and TCP/IP Protocol Suite, IP addressing, Cables, Repeaters, Bridges, Routers, Switches, Hubs, Gateway, VLANS, Network Design Case studies.	6	CO1, CO6
2.	**Transport Layer:** Introduction, Transport Layer Protocols, Congestion Control and Quality of Service User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Stream Control Transmission Protocol (SCTP)	10	CO2, CO6
3.	**Network Layer:** Introduction, packet format, IPV4 addresses, Internet protocol Version 4(IPV4), IPV6, Address resolution protocol (ARP), Reverse address resolution protocol (RARP), Internet control Message protocol (ICMP), Real time transport protocol (RTP), RTP control protocol (RTCP), VOICE OVER IP etc	7	CO3, CO6
4.	**Routing Protocols:** Unicast Routing Protocols (RIP, OSPF, and BGP), Multicasting and Multicast Routing Protocols, RIP (Routing information protocol), OSPF (Open shortest path first), BGP (Border gateway protocol), Internet group management protocol (IGMP)	7	CO3, CO6
5.	**Application Layer Protocols:** Introduction, Host Configuration: BOOTP and DHCP, Domain Name System (DNS), TELNET and SSH, File Transfer: FTP and TFTP, SNMP	5	CO4, CO6
6.	**Applications of Secure Computer Network:** Internet Security: Security aspects in Network Layer, Transport Layer, and Application Layer, working of Firewalls, Advances in the domain	4	CO5

Text Books	
1.	Behrouz A. Forouzan, "TCP/IP Protocol Suite", III Edition, Tata McGraw Hill, 2005
2.	Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw-Hill, Fourth Edition
Reference Books	
1.	W. Richard Stevens, "TCP/IP Illustrated, Volume 1", Addison-Wesley, Second Edition
2.	Internetworking with TCP-IP: Design, Implementation, and Internals, by D. E. Comer and D. L. Stevens Vol II, Prentice Hall.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5032S
Course Title	Internet of Things
Course Type	Program Elective
Prerequisites:	
Course Outcomes: At the end of the course student will be able to: **CO1.** Analyze the importance of various aspects of IoT. **CO2.** Apply different tools for interoperability for IoT. **CO3.** Design different SDN for IoT. **CO4.** Analyze Data Handling and Analytics in IoT. **CO5.** Design and develop different application in IoT. **CO6.** Create different case studies in IoT.	

	Course Contents	Hrs.	CO
1.	**Fundamentals of Internet of Things:** Introduction to IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications.	4	CO1
2.	**Interoperability in IoT:** Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi.	6	CO2
3.	**Implementation of IoT:** Implementation of IoT with Raspberry Pi, Introduction to SDN, SDN for IoT.	8	CO3
4.	**Data Handling in IOT:** Data Handling and Analytics, Cloud Computing, Cloud Computing, Sensor-Cloud, Fog Computing.	8	CO4
5.	**Application of IOT:** Connected Vehicles, Smart Grid, Industrial IoT. Challenges in Design and Development		CO5
6.	**Case Study:** Agriculture, Healthcare, Activity Monitoring.		CO6

Text Books	
1.	S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.
2.	S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
Reference Books	
1.	Research Papers

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5033S
Course Title	GPU Architecture and Programming
Course Type	Program Elective

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Describe concepts of the GPU architecture.
CO2. Justify memory hierarchy and usage in parallel programming.
CO3. Apply synchronization primitives in parallel programming.
CO4. Justify data transfer through streams for parallel programs.
CO5. Infer kernel functions for the real time systems.
CO6. Illustrate case studies.

	Course Contents	Hrs.	CO
1.	**Introduction:** Streaming Multi Processors, Cache Hierarchy,The Graphics Pipeline History, Graphics processors, graphics processing units, Clock speeds, CPU/GPU comparisons, heterogeneity, Accelerators, Parallel programming, CUDA / OpenCL / OpenACC	8	CO1
2.	**Memory** Memory hierarchy, DRAM / global, local / shared, private/local, textures, constant memory, Pointers, parameter passing, arrays and dynamic memory, multi-dimensional arrays, Memory allocation, memory copying across devices, Programs with matrices, performance evaluation with different memories.	6	CO2
3.	**Synchronization** Memory consistency. Barriers (local versus global), atomics, memory fence. Prefix sum, reduction. Programs for concurrent data structures such as worklists, linked-lists. Synchronization across CPU and GPU. Warp Scheduling, Divergence	8	CO3
4.	**Streams:** Asynchronous processing, tasks, task-dependence. Overlapped data transfers, default stream, synchronization with streams. Events, event-based-synchronization- overlapping data transfer and kernel execution, pitfalls.	6	CO4
5.	**Functions:** Device functions, host functions, kernels, functors, Optimization examples : optimizing Reduction Kernels Optimization examples : Kernel Fusion, Thread and Block OpenCL basics and OpenCL for Heterogeneous Computing Support: Debugging GPU programs. Profiling, profile tools, performance aspects	8	CO5
6.	**Advanced topics:** Case studies, Dynamic Parallelism, Unified virtual memory, Multi-GPU processing, Peer access, Heterogeneous processing	6	CO6

Text Books	
1.	Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-mei Hwu; Morgan Kaufman; 2016
Reference Books	
1.	CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012
2.	Heterogeneous Computing with OpenCL" – Benedict Gaster,Lee Howes, David R. Kaeli

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5034S
Course Title	Graph Mining
Course Type	Program Elective

Prerequisites: Fundamentals of probability and linear algebra.

Course Outcomes: At the end of the course student will be able to:

CO1. Demonstrate deep knowledge of the fundamentals of graph matching, visualization and data mining.

CO2. Design and analyze the graph patterns for graph based application.

CO3. Finding topological frequent patterns from graph database.

CO4. Develop efficient and salable implementations of graph mining algorithms.

CO5. Design a decision tree based on chunkingless graph based induction for graph application.

CO6. Applying graph mining knowledge to design effective solution to real-life graph analytic problems

	Course Contents	Hrs.	CO
1.	**Fundamentals of Graph Mining:** Terminology, Graph Databases Graph Matching—Exact And Error-Tolerant Methods And The Automatic Learning Of Edit Costs : Introduction, Definitions and Graph Matching Methods, Learning Edit Costs, Experimental Evaluation. Graph Drawing Techniques, Examples of Visualization Systems	4	CO1
2.	**Graph Patterns And The R-Mat Generator:** NetMine and R-MAT, Experiments Discovery Of Frequent Substructures : Introduction, Preliminary Concepts, Apriori-based Approach, Pattern Growth Approach, Variant Substructure Patterns, Experiments and Performance Study DFS Approach (gSpan and others), Diagonal and Greedy Approaches, Constraint-based mining and new algorithms, Mining Frequent Subgraphs.	8	CO2
3.	**Finding Topological Frequent Patterns From Graph Datasets:** Frequent Pattern Discovery from Graph Datasets, Problem Definitions, FSG for the Graph-Transaction Setting, SIGRAM for the Single-Graph Setting, GREW, Scalable Frequent Subgraph Discovery Algorithm.	6	CO3
4.	**Unsupervised And Supervised Pattern Learning In Graph Data:** Mining Graph Data Using Subdue, Comparison to Other Graph-Based Mining Algorithms, Comparison to Frequent Substructure Mining Approaches, Comparison to ILP Approaches Graph Grammar Learning : Introduction, Related Work, Graph Grammar Learning, Empirical Evaluation	6	CO4

5.	**Constructing Decision Tree Based On Chunkingless Graph-Based Induction:** Graph-Based Induction Revisited, Problem Caused by Chunking in B-GBI, Chunkingless Graph-Based Induction (Cl-GBI), Decision Tree Chunkingless Graph-Based Links Between Formal Concept Analysis And Graph Mining : Presentation, Basic Concepts and Notation, Formal Concept Analysis, Extension Lattice and Description Lattice Give Concept Lattice, Graph Description and Galois Lattice, Graph Mining and Formal Propositionalization, Kernel Methods For Graphs : Introduction, Graph Classification, Vertex Classification.	8	CO5
6.	**Applications of Graph Mining:** Web mining, centrality analysis, Link analysis algorithms, graph clustering and community detection, Node classification and Link prediction, Influential spreaders, Influence maximization, Geo-social and location based networks.	6	CO6

Text Books	
1.	Diane J. Cook , Lawrence B. Holder, Mining Graph Data, Wiley Publication, 2010.
Reference Books	
1.	Deepayan Chakrabarti and Christos Faloutsos, Graph Mining: Laws, Tools, and Case Studies, Synthesis Lectures on Data Mining and Knowledge Discovery, Morgan & Claypool Publishers, 2012
2.	Charu C. Agrawal, Haixun Wang, Managing and Mining Graph Data, Springer, 2012.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5035S
Course Title	Algorithms for Data Science
Course Type	Program Elective

Prerequisites: probability theory, data mining.

Course Outcomes: At the end of the course student will be able to:

CO1. Describe foundations of data analysis.
CO2. Illustrate data reduction techniques.
CO3. Apply data extraction techniques to data.
CO4. Demonstrate information extraction from data for applications.
CO5. Illustrate data clustering for the applications.
CO6. understand Predictive analysis for time series data and streaming data.

	Course Contents	Hrs.	CO
1.	**Introduction:** Data Science, Forecasting NASDAQ Stock Prices, Algorithms, Data Reduction, Dictionaries, Data Reduction, Similarity Measures.	6	CO1
2.	**Scalable Algorithms and Associative Statistics:** Associative Statistics, Univariate Observations, Multivariate Data, Linear Regression, Hadoop Ecosystem, Developing a Hadoop Application, MapReduce Algorithm.	6	CO2
3.	**Data Visualization:** Principles of Data Visualization, Making Good Choices: Univariate Data, Bivariate and Multivariate Data, Harnessing the Machine,	8	CO3
4.	**Extracting Information from Data:** Linear Regression Model, Least Squares, Confidence Intervals, Distributional Conditions, Hypothesis Testing, Factors, Extra Sums-of-Squares F-test, Analysis of Residuals, Healthcare Analytics.	6	CO4
5.	**Cluster Analysis:** Hierarchical Agglomerative Clustering, The k-Means Algorithm, Distance Metrics, k-Nearest Neighbor Prediction Function, Exponentially Weighted k-Nearest Neighbors, Accuracy Assessment, k-Nearest Neighbor Regression, Multinomial Naïve Bayes Prediction Function.	8	CO5
6.	**Forecasting and Streaming:** Time series data analytical methods, Drift and Forecasting, Holt-Winters Exponential Forecasting, Regression-Based Forecasting, Time-Varying Regression Estimators, Forecasting with a NASDAQ Quotation Stream, Twitter Streaming API, Sentiment Analysis.	8	CO6

Text Books

1. Fan, J., Li, R., Zhang, C.-H., and Zou, H. Algorithms for Data Science. CRC Press, 2020.
2. Brian Steele, John Chandler, Swarna Reddy. Algorithms for Data Science, Springer, 2016.

Reference Books

1. Buehlmann, P. and van de Geer, S. Statistics for High-Dimensional Data: Methods, Theory and Applications. Springer, New York, 2011.
2. Hastie, T., Tibshirani, R., and Wainwright, M. Statistical learning with sparsity. CRC press, New York, 2015.
3. Hastie, T.J., Tibshirani, R. and Friedman, J. The elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd ed). Springer, New York, 2009.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5002S
Course Title	Research Methodology and IPR
Course Type	Program Core (Mandatory Learning)

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. To Explore research and describe the research process and research methods.

CO2. Model and visualize the processes and requirements for conducting successful research.

CO3. Identify the requirement of report writing and apply over it.

CO4. To investigate and apply the basic aspects of the scientific conduct and publication ethics in order to demonstrate through software approach.

CO5. To apply knowledge in publication ethics and investigate misconduct for the exploration of required IT Acts in research project.

CO6. To be able to present, review and publish on scientific paper work.

	Course Contents	Hrs.	CO
1.	**Research Methods:** Objectives of Research, Various Steps in Scientific Research, Types of Research; Research Problem , Research Design , Survey Research , Case Study Research and hypothesis,Sampling , Measurement and Scaling techniques , Methods of data collection, Design of Survey and Experiments , Hypothesis design	6	CO1
2.	**Computer Application in Research Methodology:** C Data Processing and Modeling :Data processing and Measures Mathematical model formulation for queries using relational algebra, Design of software Architecture ,Database design, Algorithm Design ,GUI design ,Model building and decision making , Probability Distributions, Fundamentals of Statistical Analysis and Inference, Correlation and Regression ,Classification ,Clustering	5	CO2
3.	**Report writing:** Structure and Components of Research Report, Types of Report, Layout of Research Report, Writing research proposal ,Mechanism of writing a research report, Performance evaluation and curve fitting, Result declaration by various graphs and charts	4	CO3
4.	**Scientific conduct and publication ethics:** Ethics with respect to science and research,Intellectual honesty and research integrity, falsification, fabrication and plagiarism., duplicate and overlapping publication, salami slicing,Selective reporting and misinterpretation of data,Best practices/standards setting initiatives and guidelines: COPE, WAME, etc,Publication misconducts: definition, concept, problems that lead to unethical behavior and vice versa, types,Violation of publications ethic, authorship and contribution ship, Identification of publication misconduct, complaints and appeals,Software tools: Use of plagiarism tool like Turnitin, Urkund, and other open-source software tool	6	CO4

5.	**Publication ethics and misconduct:** Subject specific ethical issues, FFP, authorship,Conflict of interest,Complaints and appeals: examples and fraud from India and abroad,IT Acts for handling misconduct.	5	CO5
6.	**Application Of Results and Ethics:** Ethical issues , ethical committees , Commercialization , Code of Research Ethics Intellectual property Trademark rights ,Copyright,Patent ,Plagiarism ,royalty Databases Indexing databases, Citation databases: Web of science, Scopus etc. Research Metrics:Impact factor of journal as per citation report, SNIP, SJR, IPP, Cite score ,Metrics: h-index, i10-index, g-index, altmetrics	6	CO6

Text Books	
1.	Research Methodology by G.C.Ramamurthy Dreamtech Publications
2.	C.R. Kothari, Research Methodology Methods and Techniques, 2/e, VishwaPrakashan, 2006
3.	MacIntyre, A., 2003. A Short History of Ethics. a history of moral philosophy from the Homeric age to the 20th century. Routle
4.	Bhaskar, D.,2019. Ethics in Science Education, Research and Governance. Current Science, 117(10), pp.1736-1737.
Reference Books	
1.	Engineering Optimization methods and applications A.ravindran ,Wiley publication
2.	Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5013T
Course Title	Software Architecture
Course Type	Program Core

Prerequisites: Object Oriented Software Engineering, Programming language.

Course Outcomes: At the end of the course student will be able to:

CO1. To build knowledge on software architecture ii) To develop architectural approaches from requirements and manage traceability between architecture and requirements iii) iv) To learn Analysis, Implementation and Deployment Apply key project management concepts to software projects.

CO2. To develop architectural approaches from requirements and manage traceability between architecture and requirements.

CO3. To teach students the basic skills in reasoning about and expressing software designs

CO4. To learn Analysis, Implementation and Deployment

CO5. Practice human resource management and communications management techniques for software projects.

CO6. Practice risk management and procurement management techniques for software projects.

	Course Contents	Hrs.	CO
1.	**Fundamental of Software Architecture:** Prescriptive vs Descriptive Architecture, Architectural Design- DSSA, Architectural Pattern, Architectural Styles: Layered styles, Dataflow styles, Shared memory, interpreter Style, Implicit Invocation Styles, Peer to Peer Styles. Complex Architectural Style: C2 and CORBA Connectors: Roles, Types of Connector, Data Distribution connector: Event based, Grid-based, Client-server based, P2P based.	9	CO1
2.	**Architectural Modelling::** Connector Roles, Connector Types and Their Variation Dimensions, Example Connectors, Modeling Concepts, Ambiguity, Accuracy, and Precision, Description Language: Darwin, Rapide, Wright. Domain and Style-Specific ADLs: Koala, Weaves AADL . Visualization Techniques: Textual, Informal Graphical Editor, UML, LTSA, xADL 2.0, MTAT	8	CO2
3.	**Architectural Analysis:** Analysis Goal, Scope of Analysis, Types of Analysis Analysis Techniques: Inspection and Review Based: ATAM, Model based: Wright, Reliability Analysis	6	CO3
4.	**Applied Architectures and Styles, Designing for Non-Functional Properties:** Distributed and Networked Architectures, Architectures for Network-Based Applications, Decentralized Architectures, Service-Oriented Architectures and Web Services, Efficiency, Complexity, Scalability and Heterogeneity, Adaptability, Dependability.	9	CO4

5.	**Role of architecture in Software engineering:** Enterprise Architectures, Zachman's Framework; Architectural Styles, Design Patterns; Architecture Description Languages; Product-line architectures; Component based development	6	CO5
6.	**Design Patterns:** Basic patterns: facade, adapter, flyweight ; delegates: visitors, command, memento; grammars: composite, decorator, interpreter; frameworks: template method, factory, abstract factory; separation of concerns: observer, mediator, model-view-controller.	9	CO6

Text Books	
1.	Richard N. Taylor, Nenad Medvidovic, Eric M. Dashofy, Software Architecture: Foundation, Theory and Practice, Wiley, India , 2009
Reference Books	
1.	Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Miachel Stal, Douglas Schmidt.Pattern Oriented Sofware Architecture, Volumes 1 and 2
2.	M. Shaw and D.Garlan, Software Architecture: Perspectives on an Emerging Discipline, Pearson , 2006
3.	Len Bass, Paul Clements, Rick Katzman, Ken Bass. Software Architecture in Practice

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5014S
Course Title	Software Project Management
Course Type	Program Core

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Apply key project management concepts to software projects.

CO2. Discuss project management process groups and project integration management techniques for software projects.

CO3. Illustrate scope management and time management of software projects.

CO4. Illustrate cost management and quality management of software projects.

CO5. Practice human resource management and communications management techniques for software projects.

CO6. Practice risk management and procurement management techniques for software projects.

	Course Contents	Hrs.	CO
1.	**Introduction to Project Management:** Introduction to Project and Project Management, Program and Project Portfolio Management, The Role of the Project Manager. A Systems View of Project Management, Understanding Organizations, Stakeholder Management, Project Phases and the Project Life Cycle, The Context of Software Projects. Recent Trends Affecting Software Project Management.	6	CO2
2.	**The Project Management Process Groups and Project Integration Management:** Project Management Process Groups, Mapping the Process Groups to the Knowledge Areas, Developing Software Project Management Methodology. Introduction to Project Integration Management, Strategic Planning and Project Selection, developing a Project Management Plan, Project Execution, Directing and Managing Project Work, Monitoring and Controlling Project Work, Performing Integrated Change Control, Closing Projects or Phases.	6	CO2
3.	**Project Scope and Time Management:** Planning Scope Management, CollectProject Scope and Time Management:ing Requirements, Defining Scope, Creating the Work Breakdown Structure, Validating Scope, Controlling Scope, Using Software to Assist in Project Scope Management. Planning Schedule Management, Defining Activities, Sequencing Activities, Estimating Activity Resources, Estimating Activity Durations, Developing and Controlling the Schedule	6	CO2

4.	**Project Cost and Quality Management:** The Importance of Project Cost Management, Planning Cost Management, Estimating Costs, Determining the Budget, Controlling Costs, Using Project Management Software to Assist in Project Cost Management. Introduction Project Quality Management, Planning Quality Management, Performing Quality Assurance, Controlling Quality, Tools and Techniques for Quality Control.	6	CO4
5.	**Project Human Resource and Communications Management:** Introduction to Project Human Resource Management, Project Human Resource and Communications Management:The Importance of Human Resource Management, Keys to Managing People, Developing the Human Resource Plan, Acquiring the Project Team, Developing the Project Team, Managing the Project Team, Using Software to Assist in Human Resource Management. Introduction to Project Communications Management, Planning Communications Management, Managing Commuications, Controlling Communications, Information Distribution, Performance Reporting, Managing Stakeholders.	6	CO5
6.	**Project Risk Management and Procurement Management:** The Importance of Project Risk Management, Planning Risk Management, Common Sources of Risk on IT Projects, Identifying Risks, Performing Qualitative Risk Analysis, Performing Quantitative Risk Analysis, Planning Risk Responses, Controlling Risks. Planning Procurement Management, Planning Contracting, Conducting Procurements, Controlling Procurements, Closing Procurements.	6	CO6

Text Books	
1.	Kathy Schwalbe, "Information Technology Project Management", Revised, 7th Edition, Cengage Learning.
Reference Books	
1.	B. Hughes, M. Cotterell, "Software Project Management", Tata McGraw-Hill Education, 5th Edition.
2.	John M. Nicholas, Herman Steyn, "Project Management for Business and Technology", PHI, 4th Edition.
3.	Joseph Phillips, "IT Project Management: On Track from Start to Finish", McGraw Hill Publication, 3rd Edition.
4.	P. Jalote, "Software Project Management in Practice", Pearson Education.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5021T
Course Title	Network Administration
Course Type	Program Elective

Prerequisites: Computer Networks

Course Outcomes: At the end of the course student will be able to:

CO1. Analyze different network architectures and their features.
CO2. Perform various network operations and maintenance activities.
CO3. Identify the requirements of a data center network.
CO4. Examine and analyze the network effectively.
CO5. Design a secure network and resolve the issues.

	Course Contents	Hrs.	CO
1.	**Network Architecture Overview:** Physical Infrastructure, Logical Design, ISO/OSI Model, Network Topologies, Data Communication and Routing, Network Addressing and Security Features..	6	CO1
2.	**Network Operations and Processes:** Monitoring, Management: Access and Audit Trail, Life Cycle, Configuration Management, Deployment Process, Documentation: Network Design and Implementation, DNS, Labeling, Support: Tools, Organizational Structure, Network Services.	7	CO2, CO4
3.	**Datacenter Networks:** Build/Rent/Outsource, Requirements, Capacity Management, Life-Cycle Management, Patch Cables, Labeling, Console Access, Workbench, Tools and Supplies, Security Aspects.	7	CO1, CO3
4.	**Network Monitoring:** Overview, Monitoring Platforms, Data Collection and Performance Analysis, Systems and Service Monitoring, SNMP, Namespaces and Nameservices, Time Management, Customer Support, Incident Report.	8	CO2, CO4
5.	**Network Maintenance:** Change Management, Scaling and Expansion, Server Upgrades, Maintenance Windows, Software Repositories and Licencing, Data Storage, Backup and Restore, Disaster Recovery.	8	CO2, CO4
6.	**Network Security:** Basic Security Measures, The OSI Security Architecture, Security Attacks, Security Services and Mechanisms, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, A Model for Network Security, Standards, Legal and Ethical Issues.	6	CO1, CO5

Text Books	
1.	Thomas Limoncelli, Christina Hogan, Strata Chalup "The Practice of System and Network Administration, Volume 1", 3ed, Addison-Wesley (2017)
2.	Evi Nemeth, Garth Snyder, Trent Hein, Ben Whaley, Dan Mackin, "UNIX and Linux System Administration Handbook", 5ed, Addison-Wesley (2018)
Reference Books	
1.	Mark Burgess, "Principles of Network and System Administration", 2ed, John Wiley (2004)
2.	William Stallings, "Network Security Essentials", 6ed, Pearson (2017)

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5022T
Course Title	Wireless Communication
Course Type	Program Elective

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Justify the wireless technology requirements.

CO2. Apply the MAC protocols for the design of wireless network.

CO3. Inspect the behaviour of Mobile IP and routing protocols.

CO4. Examine the impact of transport layer protocols over wireless and wired medium.

CO5. Evaluate resource optimization techniques for better performance.

CO6. Design and deploy different wireless networks.

	Course Contents	Hrs.	CO
1.	**Introduction to Wireless technology:** Signals, Antennas, Spectrum, Radio Propagation Mechanism, Characteristics of wireless Channel, Issues in Ad Hoc Wireless Networks, Multiplexing, Modulation.	4	CO1
2.	**MAC Protocols for Ad Hoc Wireless Networks:** Introduction, Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks, Motivation for a specialized MAC, Design Goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols.	4	CO2
3.	**Wireless LAN and PAN:** Fundamentals of WLAN, IEEE 802.11 standards, HIPERLAN, Bluetooth.	8	CO2
4.	**Wireless Internet:** Introduction, Mobile IP, WAP. Routing Protocols for Ad Hoc Wireless Networks: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols: Table-Driven Routing Protocols, On-Demand Routing Protocols, Hybrid Routing Protocols, Routing protocols with efficient flooding mechanisms (OLSR), power-aware routing protocols, Multicast routing: zonal routing etc	6	CO4
5.	**Transport Layer and Security Protocols for Ad Hoc Wireless Networks:** Introduction, Traditional TCP, indirect TCP, Snooping TCP, Fast retransmit/fast recovery, transmission/time out freezing, selective retransmission, transaction oriented TCP.Network Security Attacks: Network Layer, Transport Layer, Application Layer, Key Management, Secure Routing in Ad Hoc Wireless Networks.	6	CO5

6.	**Quality of Service in Ad Hoc Wireless Networks:** Introduction, Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks, Classifications of QoS Solutions, QoS Frameworks for Ad Hoc Wireless Networks. Energy Management in Ad Hoc Wireless Networks: Introduction, Need for Energy Management in Ad Hoc Wireless Networks, Classification of Energy Management Schemes, Battery Management Schemes, Transmission Power Management Schemes, System Power Management Schemes. Recent Advances in Wireless Networks.	8	CO6

Text Books	
1.	Jochen Schiller, "Mobile communications", 2nd Edition, Pearson Education, 2008.
2.	C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", 3 rd Edition, Pearson education, 2008.
Reference Books	
1.	Wiiliam Stallings, "Wireless Communications and Networks" Prentice Hall, 2nd edition, 2005.
2.	C K Toh, "Ad Hoc Mobile Wireless Networks: Protocols and Systems", 1st Edition, Pearson education, 2002.
3.	Rappaport, "Wireless Communications Principals and Practices", 2nd Edition, Pearson Education Pvt. Ltd, 2003.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5023T
Course Title	Big Data Analytics
Course Type	Program Elective

Prerequisites: Database Management System, Java, Python, AI, Machine Learning.

Course Outcomes: At the end of the course student will be able to:

CO1. To analyse the important components of big data.

CO2. Illustrate different components in Hadoop and MapReduce.

CO3. Develop problem solving skills like Collect, manage, store, query, and analyze various forms of Big Data using NoSQL.

CO4. Solve different problems using data streaming in big data analytics.

CO5. To apply adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.

CO6. To analyse spark framework of big data analytic.

	Course Contents	Hrs.	CO
1.	**Introduction to Big Data and Hadoop:** Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions,Concept of Hadoop Core Hadoop Components; Hadoop Ecosystem	4	CO1
2.	**Hadoop HDFS and MapReduce:** Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce Hadoop Limitations	4	CO2
3.	**NoSQL:** Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems	6	CO3

4.	**Mining Data Streams:** The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data techniques in a Stream Filtering Streams: Bloom Filter with Analysis,Counting Distinct Elements in a Stream, Count-Distinct problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Frequent Items in a Stream, Sampling Methods for Streams, Frequent Item sets in Decaying Window,Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	6	CO4
5.	**Finding Similar Items, Clustering, and Real-Time Big Data Models:** Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance. CURE Algorithm, Stream-Computing, A Stream-Clustering Algorithm, Initializing and Merging Buckets, Answering Queries PageRank Overview, Efficient computation of PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering. Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph.	6	CO5
6.	**Big Data Analytics Frameworks:** Spark Framework: Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix, Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features,Spark SQL and GraphX: SQL Context, Importing and Saving data, Data frames – using SQL, GraphX overview, Creating Graph, Graph Algorithms, Spark Streaming: Overview, Errors and Recovery, Streaming Source, Streaming live data with spark.	7	CO6

Text Books	
1.	CreAnand Rajaraman and Jeff Ullman —Mining of Massive Datasets, Cambridge University Press, 2014
2.	Alex Holmes —Hadoop in Practice, Manning Press, Dreamtech Press.
3.	Dan Mcary and Ann Kelly — Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press
Reference Books	
1.	Bill Franks , Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics, Wiley
2.	Chuck Lam, Hadoop in Action, Dreamtech Press
3.	Jared Dean, Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4.	Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed, 2010.

Programme Name	M. Tech. Computer Engineering (Specialization in Network Infrastructure and Management Systems)
Course Code	CONM5031S
Course Title	Network Security
Course Type	Program Elective

Prerequisites: Networking.

Course Outcomes: At the end of the course student will be able to:

CO1. Demonstrate the concept of cryptography, Network security ,Layered Architecture.

CO2. Evaluate network Stack Vulnerabilities, threats and counter measures

CO3. Analyze the network and web attacks at different layers of TCP/IP stack.

CO4. Explore a better understanding of Network Security Protocols.

CO5. Apply the fundamentals of security in programs, operating systems and databases.

	Course Contents	Hrs.	CO
1.	**Overview of Security:** Motivation, Terminology/Background, Cryptography Overview, Confidentiality, Integrity, Authentication: Foundations,Symmetric key encryption, Block modes, Asymmetric key encryption, Hashes, MACs, Digital Signatures, key distribution, one way/mutual/mediated authentication,Protocols Overview,Introduction to Network security ,Layered architecture, Client Server architecture, Peer-to-Peer Architecture.	4	CO1
2.	**Vulnerabilities and Threat in Network Stack:** Basic services used and provided by TCP/IP Stack,Types of devices constituting a network. Concept of Internet Service Providers (ISPs)and overall conceptual view of the Internet. Routing fundamentals. Different types of networks such as LAN, WAN, VPN, etc, TCP/IP Protocol and its Vulnerabilities, Hyper Text Transfer Protocol (HTTP) and corresponding cyber security vulnerabilities.TCP/UDP/IP Vulnerabilities,Data link layer protocol vulnerability, Routing attacks.	7	CO2
3.	**Network and Web Attacks:** Attacks at link/network/transport/application layer,Denial of Service (DOS) attacks, Firewalls, Intrusion Detection,Malware and its types, The OWASP top 10-attacks,Client side and Server side attacks: Injection, Vulnerability, SQL injection, Cross Site Scripting (XSS) . Session Hijacking,Phishing, Click jacking, scripting, Broken Authentication and Session Management, Insecure Direct Object References, Cross Site Request Forgery (CSRF) Vulnerability, Failure to Restrict URL Access, Invalidated Redirects and Forwards.	7	CO3

4.	**Network Security protocols:** Application Layer: SSH.PGP,MIME,Transport Layer: TLS/SSL, Network Layer: IPSec, Link Layer: WPA, WEP, Open source tools for defense mechanism, Network Security controls, How to use network analysis tool: Wireshark and NMAP, ESAPI structure: security mechanism to mitigate the top 10 threats of OWASP, Defenses against the same.	7	CO4
5.	**System Security:** Introduction to System Security, Server Security, OS Security,Database Security, Various concepts of system and server security,overview of program security.	7	CO5
6.	**Advances in network security:** Cyber Security and Recent Technologies ,Security aspects in IoT, Cloud Computing and Image/video data. Bio-metrics, Mobile Computing and Hardening on android and ios, IOT Security, Android Malware Analysis, Experimentation using open source tools	7	CO5, CO1

Text Books	
1.	William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006
2.	Network Security Bible second edition by eric cole
Reference Books	
1.	
2.	

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5032S
Course Title	Blockchain Technology
Course Type	Program Elective

Prerequisites: Data Structures, Algorithms, Operating System, Computer Networks.

Course Outcomes: At the end of the course student will be able to:
CO1. Identify Blockchain structure and its importance.
CO2. Differentiate Blockchain Platforms and their working.
CO3. Classify consensus algorithms for different case studies.
CO4. Design smart contract for real world applications.
CO5. Asses security issues of blockchain and smart contracts.
CO6. Demonstrate skills to build cryptocurrency applications based on Blockchain Technology.

	Course Contents	Hrs.	CO
1.	**Introduction:** Concepts of cryptocurrency and Blockchain, Advantages over Traditional Databases, Block in a Blockchain, Concept of Blockchain parameters- Header, Miners, Difficulty, Nonce, Stakes, Forking, Double- Spending Problem; Types of Blockchain: Public, Private, Consortium.	4	CO1
2.	**Blockchain Platforms:** Bitcoin Network and Architecture, Transaction in Bitcoin Network, Mining, Creation of Coins, Consensus Mechanisms and Validation: Proof of Work (PoW), Proof of Stake (PoS), Practical Byzantine Fault Tolerance (PBFT), Bitcoin Security issues. Ethereum vs. Bitcoin, Transactions, Ethereum Blocks, Mining Algorithm, Gas, Fees, Eth 2.0 GHOST Protocol.	8	CO2
3.	**Consensus Algorithms::** Study and comparison of different consensus algorithms: Algorand, Ouroboros, Ethereum's consensus, Ripple Protocol Consensus Algorithm (RPCA), etc	4	CO3
4.	**Smart Contracts Fundamentals:** Introduction to Smart Contracts, Framework of smart contract, Life cycle of smart contract, Solidity, Writing and Deploying Smart Contracts in Solidity, Vulnerabilities in Smart Contracts, Attacks, Prevention of Attacks.	6	CO4
5.	**Security:** Wallets and Keys, User Addresses and Privacy Security issues in Blockchain: Anonymity, Sybil Attacks, Selfish Mining, 51/49 ratio Attacks	4	CO5
6.	**Case Studies:** Application based: e-Governance, e-Commerce, Database Applications where third party is involved Use Cases: Cryptocurrency and Other Sectors like Finance, Voting System, and Healthcare, etc. Block chain in Social Networking, block chain in 5G	9	CO6

Text Books	
1.	Andreas M. Antonopoulos, Gavin Wood, Dr. Gavin Wood. Mastering Ethereum: Building Smart Contracts and DApps. O'Reilly Media, Incorporated, 2018.
2.	A. Narayanan, J. Bonneau, E. Felten, A. Miller, and S Goldfeder, "Bitcoin and Cryptocurrency Technologies", Princeton University Press, 2016
3.	Andreas M. Antonopoulos. Mastering Bitcoin Programming the Open Blockchain. O'Reilly Media 2017.
Reference Books	
1.	M. Swan, "Blockchain: Blueprint for a New Economy", OReilly, 2015

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5033S
Course Title	Information Retrieval
Course Type	Open Elective

Prerequisites: Data Mining, DBMS.

Course Outcomes: At the end of the course student will be able to:

CO1. Understand the working, significance, applications of Information retrieval systems.

CO2. Compare different IR models.

CO3. Design text and multimedia indexing structures for searching of web documents.

CO4. Justify the evaluation techniques to measure the performance of Information Retrieval System.

CO5. Apply machine learning algorithms for information retrieval.

CO6. Design image retrieval algorithms.

	Course Contents	Hrs.	CO
1.	**Introduction:** Information Retrieval systems, Working with electronic text, Test Collections, Open source IR systems,Information versus Data Retrieval, Basic Concepts: The Retrieval Process, Logical View of Documents. Modelling: A Taxonomy of IR Models,Reference Collections. Significance of Information Retrieval, Impact of the web on Data Retrieval, Applications of Data Retrieval, Basic Data Retrieval System Architecture, Relationships between Digital library and IRS, Open Source IR Systems : Lucene , Wumpus	4	CO1
2.	**Basic Searching and Indexing:** Preprocessing: Simple Tokenizing, Stop-word Removal, Stemming and Lemmatization,Boolean and vector-space retrieval models,Sparse Vectors, Positional Postings, Inverted (static and dynamic) indices ,Index Construction, Index Compression, Term weighting, TF-IDF weighting, cosine similarity, Relevance feedback and query expansion. Language Model based IR, Probabilistic Model, Binary Independence Model, Latent Semantic Indexing Model,	8	CO2
3.	**Evaluation:** Data Retrieval System Evaluation, Standard test Collections, Evaluation of Unranked Retrieval Sets, Evaluation of Ranked Retrieval Results, Assessing Relevance, Evaluations on Benchmark Text Collections. The Text Retrieval Conference (TREC), Using Statistics in Evaluation, Minimizing Adjudication Effort, Nontraditional Effectiveness Measures, Measuring Efficiency: Efficiency Criteria, Queueing Theory, Query Scheduling, Caching.	4	CO3

4.	**Web Search:** Web Search Basics, Web Crawling and Indexing, XML retrieval, Link Analysis, Page Rank and HITS algorithms, Searching and Ranking, Relevance Scoring and ranking for Web, Hubs and Authorities. Multimedia IR: Spatial Access Methods, Distance Function, Generic Multimedia Indexing Approach	6	CO4
5.	**Parallel and distributed IR:** Hadoop and Map Reduce, Personalized search, Collaborative filtering and content-based recommendation of documents and products, handling "invisible" Web,Snippet generation, Summarization, Question Answering, Cross-Lingual Retrieval. Vector space classification, Support vector machines and machine learning on documents, Flat clustering, Hierarchical clustering, Matrix decomposition. Naive Bayes, Decision Trees, and Nearest Neighbor, expectation maximization (EM).	8	CO5
6.	**Image Retrieval:** Content-based Image Retrieval, Image Feature Description, Order system, Texture, Shape, Characteristics of Image Queries, Image Retrieval systems.	6	CO6

Text Books	
1.	C. Manning, P. Raghavan, and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2.	Ricardo Baeza -Yates and Berthier Ribeiro – Neto, Modern Information Retrieval: The Concepts and Technology behind Search 2nd Edition, ACM Press Books 2011.
3.	Stefan Büttcher, Charles L, A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and evaluating search engines, MIT Press, 2010
Reference Books	
1.	David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2004.
2.	Frakes, Information Retrieval: Data Structures and Algorithms, Pearson, 2009
3.	Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1 st Edition Addison Wesley, 2009.
4.	Mark Levene, An Introduction to Search Engines and Web Navigation, 2nd Edition Wiley, 2010.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5065T
Course Title	Human Computer Interaction
Course Type	Open Elective

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Analyze the importance of various aspects of HCI.
CO2. Apply different tools for interactive system design for HCI
CO3. Design different web interfaces of HCI.
CO4. Create interaction using different interactive style.
CO5. Design and develop different usability aspects of software system.
CO6. Create software system using UX and UI. s

	Course Contents	Hrs.	CO
1.	**Introduction to Human-Computer Interaction:** Objective, Overview and historical evolution of HCI, Ergonomics, Interaction styles, Elements of the WIMP (windows, icons, pointers, menus) interface, interactivity, the context of the interaction, paradigms for interaction, Cognitive walkthrough.	4	CO1
2.	**Design process:** Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions. Screen Designing, Interaction Design, Interactive Design, Interface Design, GUI Design, Software Tools, Dialog Design.	8	CO2
3.	**Web Interfaces:** Designing Web Interfaces – Drag and Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow	4	CO3
4.	**Interaction Styles:** Concept of combined reality, virtual reality, technologies, existing scientific and commercial projects. Sensing and tracking. Sensors for sensing of fingers, hands and touching. Interactive digital surfaces, manipulation of digital objects, displays with rear projection.	6	CO4
5.	**Usability Testing and Analytic Evaluation:** Involves usability testing through examples, the basics of experimental design, the methods used in usability testing, the role of field studies in evaluation, the important concepts associated with inspection methods, how heuristic evaluation can be adapted to evaluate different types of interactive products, what is involved in doing heuristic evaluation and various kinds of walkthrough, how to perform predictive technique, and when to use them, the advantages and disadvantages of using analytical evaluation.	8	CO5
6.	**Design Case Studies:** 1] Multikey press Hindi Text Input Method on a Mobile Phone, 2] GUI design for a mobile phone based Matrimonial application. 3] Employment Information System for unorganized construction workers on a Mobile Phone	6	CO6

Text Books	
1.	Interaction design: Beyond Human-Computer Interaction, 4/e by J. Preece, Y. Rogers and H. Sharp and Published by John Wiley and Sons
2.	Designing the User Interface, 5/e (Pub. Pearson) - Shneiderman B., Plaisant C., Coen M., Jacobs S
3.	Bill Scott and Theresa Neil, —Designing Web Interfaces, First Edition, O 'Reilly.
Reference Books	
1.	Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education.
2.	Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.
3.	User Interface Design, Soren Lauesen, Pearson Education.

Programme Name	M. Tech. Computer Engineering
Course Code	COSE5066T
Course Title	Machine Learning
Course Type	Open Elective-II
Prerequisites: Basic understanding of probability and statistics, linear algebra and calculus.	
Course Outcomes: At the end of the course student will be able to: **CO1.** . Gain knowledge about basic concepts of Machine Learning **CO2.** Identify machine learning tools and techniques solving real time problems **CO3.** Solve the problems using various machine learning techniques **CO4.** Optimise and test the model for best performance. **CO5.** Exploring the advances in machine learning future to solve real time case studies	

	Course Contents	Hrs.	CO
1.	**Introduction:** Introduction and Basic Concepts of ML, Taxonomy of ML, Types of machine learning: Supervised Learning, Regression Vs Classification, Unsupervised Learning, Clustering, Classification, Rules mining, Prediction, Issues in machine learning.	6	CO1
2.	**Machine learning Tools:** R, Python, Scikit Learn, BigML , WEKA, or. any one platform to make machine learning in practice with case studies.Data and Data understanding, Data preprocessing. Learning Association Rules: Mining Frequent Patterns, Apriori algorithm, and other varients of Association rules mining algorithms.	8	CO2, CO3
3.	**Supervised Learning:** Decision Trees: ID3, Classification and Regression Trees, Regression. Neural Networks, Support vector machines, Generalized Linear Models (GLM), Probabilistic Learning: Bayesian Learning, Bayes Optimal Classifier, Naıve Bayes Classifier, Markov Decision Process (MDP). Ensemble Learning: Model Combination Schemes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking	08	CO1, CO3
4.	**Unsupervised learning:** Clustering, Instance-based learning, K-nearest Neighbour, Dimensionality Reduction, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models.	6	CO3

5.	**Balanced Machine Learning Model and Model Evaluation:** What Are Evaluation Metrics? Types of Predictive Models, Confusion Matrix, F-Score, Accuracy, Precision, Recall, Gain and Lift Charts , Kolmogorov-Smirnov Chart , Area Under the ROC Curve, Log Loss, Gini Coefficient, Concordant – Discordant Ratio, Root Mean Squared Error (RMSE), Root Mean Squared Logarithmic Error, R-Squared/Adjusted R-Squared, Cross Validation, Bias-Variance and Error Analysis, Bias/variance trade-off, Error Analysis, Normal Equations, Variance, Gradient Descent, Model Balancing: Overfitting, underfitting, Variance, Bias and Model Complexity in Machine Learning.	8	CO4
6.	**Introduction to Advanced topics in Machine Learning:** Deep Neural Networks, Vectorization, Backpropagation, Forward propagation, multi-label classification, Conditional Random Fields (CRFs), Reinforcement Learning, Spectral clustering-Semi-supervised learning. Deep Learning Models: Introduction to NN, important terms in NN, DNN, CNN, RNN, Model Training and testing, Pretrain models, parameter tuning and customized models, Deep learning in images processing, video processing, text processing.	6	CO5

Text Books	
1.	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition, 2014.
2.	Miroslav Kubat, "An Introduction to Machine Learning", Springer, 2015.
Reference Books	
1.	Tom Mitchell, "Machine Learning", McGraw-Hill, 2017
2.	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", Third Edition, OReilly Publication, 2022
3.	John D. Kelleher, Deep Learning, The MIT Press Essential Knowledge series, 2019
4.	Jerome Friedman, Robert Tibshirani, Trevor Hastie, "The Elements of Statistical Learning" Springer, 2017.