National Institute of Technology Raipur

(An Institute of National Importance)

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Department of Information Technology

MTech (IT) SEMESTER: I <u>(New Scheme & Syllabus)</u>

S.No.	Board of Studies	Sub. Code	Subject Name	Periods/week			Examination Scheme					Total Marks	Credits
				L	T	P	TA	FE	SE	ESE	Pract. ESE		
1	Information Technology	IT MC101	Distributed and Parallel System	4	0	-	20	15	15	100	-	150	4
2	Information Technology	IT MC102	Advanced Algorithms and Data Structures	4	0	-	20	15	15	100	-	150	4
3	Information Technology	IT MC103	Advanced Machine Learning	4	0	-	20	15	15	100	-	150	4
4	Information Technology	IT ME11X	Elective-1	4	0	-	20	15	15	100	-	150	4
5	Information Technology	IT ME12X	Elective-2	4	0	-	20	15	15	100	-	150	4
6	Information Technology	IT ML101	Lab 1 (Advanced Programming Lab)	-	-	3	75	-	-		50	125	2
7	Information Technology	IT ML102	Lab 2 (Advanced Machine Learning Lab)	-	-	3	75	-	-		50	125	2
			Total	**20**	**0**	**6**	**250**	**75**	**75**	**500**	**100**	**1000**	**24**

S.No	Elective-1	Elective-2
1	Mathematical Concepts of Computer Science	Natural language Processing
2	Biomedical Signal and Image Processing	Advanced Computer Architecture
3	Advanced Database Management System	Advanced Computer Network
4	Cloud Computing	Blockchain Technology
5	Quantum Computing and Algorithm	Bioinformatics
6	Advanced Software Design and Architecture	Computational geometry

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course – Name	**Distributed and Parallel Computing**
Course – Code	**ITME111**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 1**

Course Outcomes:

Students will be able to –

CO-1	Understand the fundamentals and applications of Distributed Systems & other Computing paradigms.
CO-2	Know the synchronization mechanisms in Distributed Systems.
CO-3	Apply various Mutual Exclusion, Election and Distributed Consensus algorithms.
CO-4	Realize Distributed transaction and Distributed Storage mechanisms.
CO-5	Know Failure Recovery and Deadlock Detection algorithms in Distributed Systems.
CO-6	Explore and implement Parallel Computing and High-Performance Computing systems

Course Contents:

UNIT-1	**Introduction to Distributed Computing:** Introduction to Distributed Systems and other Computing paradigms, advantages of Distributed Systems over Centralized systems, fundamental characteristics of Distributed Systems, types of Distributed Systems, design challenges and applications of Distributed Systems. Models of Distributed Systems: physical models, fundamental models and architectural models. Peer to Peer & Client-Server model, verities of Client-Server model.
UNIT-2	**Clocks in Distributed Computing:** Concept of clock in Distributed System, Clock synchronization. Physical clocks: GMT, TAI and UTC time. Computer clock, clock skew, clock drift. External and internal synchronization, Cristian's algorithm, Berkeley Algorithm, Network Time Protocol (NTP). Logical clocks: Causal Ordering, Lamport's Logical Clock, Vector Clocks, global state, consistent and inconsistent cut, Chandy and Lamport's algorithm to construct consistent cut.

UNIT-3	**Mutual Exclusion, Election, and Consensus in Distributed Systems:** Distributed Mutual Exclusion, Critical Section and requirements for Mutual Exclusion, Mutual Exclusion Algorithms: Central Server algorithm, Ring-based algorithm, Ricart and Agrawala's algorithm. Election Algorithms: Election algorithm requirements, Chang and Robert's Ring-based algorithm, Bully algorithm. Distributed Consensus: Flood-set algorithm, Byzantine failure, Byzantine General Problem.
UNIT-4	**Distributed Transactions & Recovery:** Distributed Transaction, Distributed Storage, Replication, Recovery in Distributed System. Commit protocols: 1-Phase, 2-Phase and 3-Phase commit protocols, Distributed Deadlock Detection.
UNIT-5	**Parallel Computing:** Introduction to parallel computing, Flynn's classification. Parallel Computing topologies: Chain, Ring, Mesh, Torus, tree, Star, Cube, Hyper tree, etc. Uniform Memory Access (UMA) & Non uniform Memory Access (NUMA), Multi-processor System, Parallel Matrix Multiplication. Introduction to High-Performance Computing (HPC), architecture of a supercomputing system, Parallel algorithms paradigm. Introduction to OpenMP & MPI programming model, applications of HPC systems.

Reference Books:

1.	M. Singhal, N. G. Shivaratri, N. Shivaratri, ***Advanced Concepts in Operating Systems***, McGraw-Hill Science, 1st edition, 1994
2.	P. K. Sinha, ***Distributed Operating Systems***, PHI, 2012.
3.	Michel J. Quinn, ***Parallel Computing: Theory and Practice***, McGraw-Hill Science, 2nd edition, 2017.
4.	G. Couloris, J. Dollimore, T. Kindberg, ***Distributed Systems: Concepts & Design***, Pearson Education India, 2010.
5.	Tanenbaum Andrew S., **Distributed Systems**, 3rd edition, CreateSpace, 2017.
6.	A. D. Kshemkalyani, M. Singhal, ***Distributed Computing: Principles, Algorithms, and Systems***, Cambridge, 2008
7.	G. Hager, G. Wellein, ***Introduction to High Performance Computing for Scientists and Engineers***, CRC Press; 1st edition, 2010

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course – Name	**Advanced Algorithms and Data Structures**
Course – Code	**ITMC102**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Core**

Course Outcomes:

Students will be able to –

CO-1	Analyze worst-case running times of algorithms using asymptotic analysis.
CO-2	Classify problems into distinct complexity classes based on deterministic algorithms, approximation algorithms, and parameterized algorithms.
CO-3	Analyze the complexity of graph problems and apply it to different real word problems.
CO-4	Examine approximation algorithms and ascertain their approximation factor.
CO-5	Design and analyze efficient randomized algorithms.

Course Contents:

UNIT-1	**Foundations of Algorithms:** Algorithm Analysis, Asymptotic Notations (Big-O, Big-Theta, Big-Omega), Worst-case, Average-case, and Best-case Analysis, Amortized Analysis. Algorithm design techniques: Divide and Conquer Algorithms: Merge Sort, Quick Sort, Master Theorem and its applications; Dynamic Programming: Principles of Dynamic Programming, Examples: Fibonacci Series, Knapsack Problem; Greedy Algorithms: Principles and applications, Minimum Spanning Tree (Prim's and Kruskal's algorithms), Dijkstra's algorithm.
UNIT-2	**Advanced Data Structures:** Advanced Trees: AVL Trees, Red-Black Trees, B-Trees and B+ Trees, Heaps and Priority Queues, Binary Heaps, Heap Operations, Applications in algorithms (e.g., Dijkstra's algorithm), Hashing: Hash Functions and Hash Tables, Collision Resolution Techniques (Chaining, Open Addressing), Graph Algorithms: Graph Representation (Adjacency Matrix, Adjacency List, Graph Traversal (DFS, BFS), Shortest Path Algorithms (Dijkstra's, Bellman-Ford), Minimum Spanning Tree (Prim's, Kruskal's).
UNIT-3	**Advanced Algorithm Techniques:** Advanced Divide and Conquer, Strassen's Matrix Multiplication, Closest Pair of Points.

	Randomized Algorithms: Randomized Quick Sort, Las Vegas and Monte Carlo algorithms, Approximation Algorithms: Principles and examples (e.g., Set Cover, Traveling Salesman Problem), Parallel and Distributed Algorithms: Parallel Sorting Algorithms, Distributed Graph Algorithms.
UNIT-4	**Advanced Topics in Data Structures:** Tries Structures and Suffix Trees: Applications in text processing, Advanced Hashing Techniques: Perfect Hashing, Bloom Filters Advanced Tree Structures: Segment Trees, Fenwick Trees (Binary Indexed Trees), Persistent Data Structures: Basics and applications.
UNIT-5	**String Algorithms:** Pattern Matching (KMP algorithm, Rabin-Karp algorithm), Longest Common Subsequence, Geometric Algorithms: Convex Hull Algorithms (Graham Scan, Jarvis March), Network Flow Algorithms: Maximum Flow (Ford-Fulkerson algorithm, Edmonds-Karp algorithm), Minimum Cut, NP-Hard and NP-Complete Problems, Approximation Schemes.

Reference Books:

1.	D. C. Kozen, ***The Design and Analysis of Algorithms***, Springer, 1992.
2.	T. H. Cormen, C. E. Leiserson, and R. L. Rivest, ***Introduction to Algorithms***, PHI, 1990.
3.	R. Motwani and P. Raghavan, ***Randomized Algorithms***, Cambridge University Press, 1995.
4.	C. H. Papadimitriou, ***Computational Complexity***, Addison Wesley, 1994.
5.	***Algorithmic Graph Theory and Perfect Graphs***, Martin Charles Golumbic, 2004, Elsevier, Second Edition.
6.	***Treewidth: Computations and Approximations***, Ton Kloks, Springer-Verlag, 1994.
7.	***Algorithms and Complexity***, Herbert S. Wilf, AK Peters/CRC Press, 2002, Second Edition
8.	***Parameterized Complexity***, Rodney G. Downey and M. R. Fellows, Springer, 2012.
9.	***Approximation Algorithms***, Vijay V. Vajirani, Springer, 2001

Name of Program	M. Tech.	Semester – I	Year – I
Course – Name	**Advanced Machine Learning**		
Course – Code	**ITMC103**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Core**		

Prerequisites:

- Data Structures
- Fundamental of Computer concepts

Course Outcomes:

Students will be able to –

CO-1	To understand the fundamental principles that allow one to design machine learning algorithms.
CO-2	To become familiar with specific, widely used machine learning algorithms.
CO-3	To introduce building blocks of deep neural network architecture.
CO-4	To understand representation and transfer of knowledge using deep learning.
CO-5	To learn to use deep learning tools and framework for solving real-life problems.

Course Contents:

UNIT-1	**Introduction to Machine Learning Framework:** Machine Learning Pipeline, Key Terminology and tasks, Types of Machine Learning Techniques, Performance Evaluation, Bias-Variance Trade-off, Python machine learning environments **Data Pre-processing:** Types of features, Datatransformation, discretization, Data manipulation, standardization and Data Normalization
UNIT-2	**Feature Selection Techniques:** Filter-based techniques, Wrapper-based techniques, Embedded-based techniques,**Dimension reduction:** Principal component analysis (PCA), LDA, **Predictive Analysis**: Linear regression, Multiple Linear regression.
UNIT-3	**Supervised, Unsupervised and Semi-supervisedLearning** **Supervised Learning:** K-NN, Naive Bayes, SVM,Logistic Regression, Decision Trees,

	Randon Forest, **Ensemble methods:** Bagging, Boosting, Stacking, Voting-based techniques. **Unsupervised Learning:** K-Mean Clustering Model, Semi-supervised Learning.
UNIT-4	**Fundamental concept of Artificial Neural Network (ANN) and Deep learning (DL):** Introduction to the Neural Network**,** Training Feed-Forward Neural Networks **Convolutional Neural Network (CNN)Theory:** Convolution Operation, Pooling Operation, Base CNN Architectures, Loss Functions, Activation Functions, Optimization Algorithms (e.g., Stochastic Gradient Descent, Adam), Regularization Techniques (e.g., Dropout, L1/L2 Regularization), Batch Normalization and Dropout.
UNIT-5	**Advanced DL Architecture:** RNN, LSTM, GRU, BiGRU, Autoencoder, Generative Adversarial Networks (GAN), Graph CNN, Federated Learning.
Reference Books:	
1.	Trevor Hastie, Robert Tibshirani, Jerome Friedman "**The Elements of Statistical Learning**: Data Mining, Inference, and Prediction" (2nd Edn.), Springer, 2014.
2.	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, "***Introduction to Data Mining*",**2nd Edition, 2019, Pearson.
3.	James, Gareth, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor. "***An introduction to statistical learning****: With applications in python*"**,** Springer Nature, 2023.
4.	*Ian Goodfellow, Yoshua Bengio, Aaron Courville, "***Deep Learning***", The MIT Press, 2016*
5.	*Aurélien Géron, "**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**", O'Reilly Media.*
6.	*Francois Chollet, "**Deep Learning with Python**", Manning Publications, 2017*
7.	Buduma, N., and Nicholas Locascio. "'***Fundamentals of Deep Learning: Designing Nextgeneration Machine Intelligence Algorithms***' 2017 O'Reilly Media"
8.	Soledad Galli "***Python Feature Engineering Cookbook***",Packt Publication,2020.

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course – Name	**Mathematical Concepts of computer Science**
Course – Code	**ITMC101**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Core**

Course Outcomes:

Students will be able to –

CO-1	Apply the concepts of Linear Algebra.
CO-2	Use the Mathematical concepts to solve real world problems.
CO-3	Apply the concepts of Probability and Distribution for a given problem.
CO-4	Use the concepts of Discrete Mathematics for solving the given problem.
CO-5	Apply the concept of reduction to prove given problem is hard.

Course Contents:

UNIT-1	**Discrete Mathematics:** Sets and Relations, Mathematical Logic and Induction, Elementary Combinatorics, Recurrence Relations, Lattices as Partially Ordered Sets, Graphs, Trees. Groups, Rings and Fields.
UNIT-2	**Linear Algebra:** System of linear equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Vector spaces and subspaces, Linear transformations, Eigenvalues and eigenvectors, Orthogonality and orthogonal projections, Singular value decomposition, Applications to computer graphics, machine learning, and cryptography .
UNIT-3	**Calculus:** Limits and continuity, Differentiation and integration, Multivariable calculus (partial derivatives, gradients, multiple integrals), Optimization techniques (unconstrained and constrained).
UNIT-4	**Probability and Statistics:** Probability theory (basic concepts, random variables, distributions, Statistical inference (estimation, hypothesis testing), Regression analysis, Bayesian methods, Bayes Theorem, Summary Statistics and Independence, Markov Chain.

UNIT-5	**Complexity Theory:** Basics of algorithm analysis (time and space complexity), P vs NP problem, NP-completeness and reductions, Approximation algorithms.
Reference Books:	
1.	. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong***, Mathematics for Machine Learning***, Cambridge University Press, 2020. (for topics other than Discrete Mathematics)
2.	Joe L. Mott, Abraham Kandel, Theodore P. Baker, ***Discrete Mathematics for Computer Scientists and Mathematicians***, Second Edition, PHI, 2001.
3.	J. P. Tremblay and R. Manohar, ***Discrete Mathematical Structures with Applications to Computer Science***, MGH, 1997.
4.	Kenneth H. Rosen, ***Discrete Mathematics and its Applications with Combinatorics and Graph Theory***, Seventh Edition, MGH, 2011
5.	"***Introduction to Graph Theory***" by Douglas B. West
6.	***"Introduction to Linear Algebra"***by Gilbert Strang

Name of Program	M. Tech.	Semester – I	Year – I
Course – Name	**Biomedical Signal and Image Processing**		
Course – Code	**ITME112**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 1**		

Prerequisites:

- Basic knowledge of signal processing concepts.
- Familiarity with linear algebra and calculus.
- Introduction to programming (preferably in MATLAB or Python)
- Fundamental understanding of biomedical engineering principles

Course Outcomes:

Students will be able to –

CO-1	Demonstrate an understanding of the fundamentals of biomedical signal and image processing.
CO-2	Apply various signal processing techniques to analyze biomedical signals.
CO-3	Explain the principles and methods of medical image formation and enhancement.
CO-4	Implement advanced algorithms for the analysis and interpretation of medical images.
CO-5	Utilize software tools to perform practical biomedical signal and image processing tasks.

Course Contents:

UNIT-1	**Introduction to Biomedical Signal Processing:** Overview of Biomedical Signals, Signal Acquisition and Sampling, Noise and Artifacts in Biomedical Signals, Time-Domain Analysis of Biomedical Signals, Frequency-Domain Analysis of Biomedical Signals, Case Studies: ECG, EEG, and EMG Signal Processing.
UNIT-2	**Advanced Signal Processing Techniques**: Digital Filtering and Signal Enhancement, Wavelet Transform and Multiresolution Analysis, Adaptive Filtering, Signal Compression Techniques, Feature Extraction and Pattern Recognition, Case Studies: Signal Processing in Biomedical Instrumentation.

UNIT-3	**Introduction to Biomedical Image Processing:** Basics of Image Formation, Image Acquisition Techniques, Image Representation and Formats, Image Enhancement Techniques, Noise Reduction in Medical Images, Case Studies: Enhancing X-ray, MRI, and CT Images. .
UNIT-4	**Advanced Image Processing and Analysis:** Image Segmentation Techniques, Edge Detection and Feature Extraction, Image Registration and Fusion, Morphological Image Processing, Texture Analysis and Classification, Case Studies: Image Analysis in Medical Diagnosis.
UNIT-5	**Applications and Tools in Biomedical Signal and Image Processing:** Applications of Signal Processing in Healthcare, Advanced Algorithms in Medical Imaging, Machine Learning and Deep Learning in Biomedical Imaging, Software Tools for Signal and Image Processing (MATLAB, Python), Practical Implementation and Case Studies, Case Studies: Recent Advances in Biomedical Imaging Technology. .

Reference Books:	
1.	***Biomedical Signal Analysis*** : Rangarajan M Rangarajan.
2.	Gonzalez, R., and R. E. Woods. ***Digital Image Processing***. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN: 9780201180756 .
3.	Rabiner, L. R., and R. W. Schafer. ***Digital Processing of Speech Signals***. Upper Saddle River, NJ: Prentice-Hall, 1978. ISBN: 9780132136037.
4.	***Essentials of medical physiology***: K. Sembulingam.
5.	***DSP Principles and Algorithm***: Proakis.
6.	***Principles of Neurology***: Allan H. Ropper
7.	***EEG ERP Analysis Methods and Application***:: Nidal Kamel

Name of Program	M. Tech.	Semester – I	Year – I
Course– Name	**Advanced Database Management System**		
Course– Code	**ITME113**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1+ 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 1**		

Prerequisites:

- Database System Concepts

Course Outcomes:

Students will be able to –

CO-1	Understand the basic concepts and terminology related to distributed DBMS and its design.
CO-2	Design and develop query processing strategies.
CO-3	Understand transaction processing and concurrency control in distributed databases.
CO-4	Understand reliability and replication concepts in distributed databases

Course Contents:

UNIT-1	**Overview of Distributed Database and Distributed Database Design** Distributed Database Management Systems - Promises of distributed database, design issues of distributed databases, distributed database architecture, Distributed Database Access Primitives, Integrity Constraints in Distributed Databases, Data fragmentation, horizontal fragmentation, vertical fragmentation, Allocation of Fragments, allocation problem, allocation model, Translation of Global Queries to Fragment Queries, The Equivalence Transformation for Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping - Aggregate Function Evaluation, Parametric Queries, Database Integration, Schema Matching, Schema Integration, Schema Mapping.
UNIT-2	**Query Decomposition and Data Localization** Overview of Query Processing-objectives, Characterization of Query Processors, Layers of Query Processing, Query Decomposition and Data Localization- Localization of Distributed Data, Optimization of Distributed Queries, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization.

UNIT-3	**Distributed Transaction Management and Concurrency Control** Introduction to Transaction Management, Properties of Transactions, Types of Transactions, Distributed Concurrency Control, Taxonomy of Concurrency Control Mechanisms, Locking Based Concurrency Control Algorithms, Timestamp Based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms, Deadlock Management - The System R* ,The Architecture of System R*, Compilation - Execution and Recompilation of Queries, Protocols for Data Definition and Authorization in R*, Transaction and Terminal Management.
UNIT-4	**Reliability** Distributed DBMS Reliability, Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols.
UNIT-5	**Replication and Current Trends** Data Replication, Consistency of Replicated Databases, Update Management Strategies, Replication Protocols, Current trends in No SQL, New SQL data management issues on the cloud, Stream data management.

Reference Books:

1.	Stefano Ceri, Guiseppe Pelagatti, "Distributed Databases - Principles and Systems", Tata McGraw Hill, 2008.
2.	Ozsu M.T., Sridhar S., "Principles of Distributed database systems", Pearson education, 2011.
3.	Korth & Sudarshan, "Database system concept", Tata McGraw Hill, 2008. Optional Materials:
4.	Raghu Rama Krishnan, Johnaas Gehrke, "Database Management Systems", TataMcGrawHill, 2000.
5.	Elmasri, Navathe, "Fundamentals of Database Systems", Addison-Wesley, Fifth Edition 2008.

Name of Program	M. Tech.	Semester – I	Year – I

Course – Name	**Cloud Computing**
Course – Code	**ITME114**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 1**

Course Outcomes:

Students will be able to –

CO-1	Understand the fundamentals and applications of Computing paradigms.
CO-2	Know the Cloud Deployment and Service Delivery Models.
CO-3	Understand Virtualization and Containers.
CO-4	Apply various VM Migration techniques.
CO-5	Build, Simulate and deploy a Cloud Service.
CO-6	Identify and select the right Cloud Migration Strategy.
CO-7	Analyse the Importance of Cloud and Data Security.

Course Contents:

UNIT-1	**Introduction to Cloud Computing:**Introduction to Cloud Computing, NIST view of Cloud Computing, Various Computing Paradigms, Cloud Computing Architecture, Cloud Computing Characteristics, Benefits and Challenges of Cloud Computing, Opportunities and Challenges of Cloud Computing, Advantages and Disadvantages of Cloud Computing.
UNIT-2	**Cloud Deployment and Service Delivery Models:**Introduction to Cloud Deployment Models, Types of Cloud Deployment Models, Examples of Private, Public, Hybrid and Community Cloud. Comparison of Cloud Deployment Models. Overview of Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) model. SaaS Maturity Model, Serverless Computing. Use cases of SaaS, PaaS, and IaaS. Advantages and Disadvantages of SaaS, PaaS and IaaS. Related products and Services of SaaS, PaaS and IaaS. .
UNIT-3	**Virtualization and VM Migration:**Introduction to Virtualization, Comparison of Traditional IT Infrastructure with Virtualized Infrastructure, Virtual Machines, Types

	of Virtualizations, Hypervisor, Types of Hypervisors, Architecture of Xen Hypervisor, Architecture of KVM Hypervisor, Benefits of Virtualization, Cloud Computing vs Virtualization. Containers, Microservices, Benefits of Containers, VMs vs Containers vs Serverless Computing. Virtual Machine Migration, Virtual Machine Migration Services, Pre-copy Migration, Post-copy Migration. Load balancing in Cloud Computing.
UNIT-4	**Cloud Computing Platforms and Tools:** Overview of OpenStack, Amazon Web Services, Microsoft Azure, Google Cloud, CloudSim and Aneka. Installing a Cloud service using Eucalyptus, Open Nebula, OpenStack, Amazon Web Services, Microsoft Azure, Google App Engine. Building of a private cloud using open-source tools. Understanding various cloud plugins, Setting up a cloud environment. Working of CloudSim tool and Aneka Cloud Computing Platform.
UNIT-5	**Cloud Migration, Cloud Security and Cloud enabling Technologies:**Cloud Migration, Benefits of Cloud Migration, Cloud Migration Challenges, Cloud Migration Strategies: The 6 R's of cloud migration. Cloud Security, Importance of Cloud Security, Infrastructure Security, Network level security, Host level security, Application-level security, Data security and Storage, Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Authentication in cloud computing, Client access in cloud, Cloud contracting Model.

Reference Books:

1.	George Reese, ***Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)***, O'Reilly, 2009.
2.	Rajkumar Buyya, James Broberg, Andrzej Goscinski, ***Cloud Computing: Principles and Paradigms***", Wiley.
3.	Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, ***Cloud Computing: A Practical Approach***, McGraw Hill Education, 2017.
4.	Rajkumar Buyya, S. Thamarai Selvi, Christian Vecchiola ***Mastering Cloud Computing: Foundations and Applications Programming***, Morgan Kaufmann, 2013
5.	Barrie Sosinsky ***Cloud Computing Bible***, Wiley India Pvt Ltd, 2011.
6.	Thomas Erl, Zaigham Mahmood, Ricardo Puttini, ***Cloud Computing: Concepts, Technology & Architecture***, Pearson Education, 2013

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course – Name	**Quantum Computing and Algorithms**
Course – Code	**ITME115**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 1**

Prerequisites:

- Linear Algebra & Probability Theory
- Discrete Mathematical Structures
- Basics of Quantum Mechanics
- Programming Basics and Skills

Course Outcomes:

Students will be able to –

CO-1	Realize the potential of quantum parallelism and computing principles for solving computationally intensive problems.
CO-2	Develop quantum algorithms using several design strategies to efficiently solve the existing problems.
CO-3	Analyze performance of quantum algorithms outperforming classical algorithms.
CO-4	Simulate and implement the quantum circuits equivalent to quantum algorithms.
CO-5	Investigate the quantum algorithms as effective solutions to solve the real-world problems in diversified domains of computational science and technology.

Course Contents:

UNIT-1	**Quantum Computing Basics:** Introduction and Overview, Quantum Mechanics Fundamentals, Quantum Postulates, Quantum Parallelism and Correlations, Concept of Qubit, Quantum Information Processing, Quantum Computer Science.
UNIT-2	**Quantum Circuits Design:** Classical and Quantum Computation Model, Quantum State Transformation, Basic Quantum Gates, Quantum Circuits. Quantum-Based Circuit Designs of Classical Computation, Applications of Quantum Gates.
UNIT-3	**Quantum Design Strategies:** Quantum Parallelism (Revisited), Quantum Oracle Approach, Quantum Fourier Transform (QFT), Quantum Phase Estimation (QPE), Quantum Amplitude Amplification (QAA), Quantum Walk, Adiabatic Quantum

	Computing, Hybrid Classical-Quantum Algorithms, Quantum Error Correction.
UNIT-4	**Quantum Algorithms:** Introduction to Quantum Algorithms, Speedup Analysis, A Few Quantum Algorithms: Deutsch, Deutsch-Jozsa, Bernstein Vazirani, Simon's, Grover's, Shor's algorithms, and Quantum Computational Complexity Theory.
UNIT-5	**Quantum Programming and Realization:** Understanding Physical Realization of Quantum Computer Technology, Quantum Programming using QuEST, Quirk and IBM Qiskit and etc. Quantum Algorithmic Simulation and Emulation. Significant Research and Development of Quantum Computing in Computer Science.

Reference Books:

1.	Michael A. Nielsen & Isaac L. Chuang, ***Quantum Computation and Quantum Information***, 10th Anniversary Edition – 2010, Cambridge University Press.
2.	Phillip Kaye, ***An Introduction to Quantum Computing,*** First Published Edition – 2007, Oxford University Press.
3.	Noson S. Yanofsky and Micro A. Mannucci. ***Quantum Computing for Computer Scientists***, First Published Edition – 2008, Cambridge University Press.
4.	N. David Mermin, ***Quantum Computer Science – An Introduction***, I Edition – 2007, Cambridge University Press.
5.	Ivan B. Djordjevic, Quantum Information Processing, ***Quantum Computing, and Quantum Error Correction – An Engineering Approach***, Second Edition – 2021, Academic Press – An Imprint of Elsevier.

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course – Name	**Advanced Software Design and Architecture**
Course – Code	**ITME116**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 1**

Course Outcomes:

Students will be able to –

CO-1	To understand the objectives of Software Architectural design.
CO-2	To learn various Software Architecture prevalent wrtMVC, SOA etc.

Course Contents:

UNIT-1	**Introduction to Algorithm Design, Software Design and Architecture:** What are Software system Design objectives, purpose and approaches of efficient system design, and Functional Independence in Software Design with Coupling and Cohesion? Overview of OO Design: Class Diagrams Object Diagrams. Sequence and Collaboration Diagrams, Static and dynamic modelling approaches for efficient design
UNIT-2	**UNIT -2: Software Design Principles:** Role of Modelling and Design, Design Metrics, OO Software Design. Design Principles with Applications. Iterative Refinement Behaviour, Iterative Refinement Minimalism. Mobile Software and Design: Characteristics and Requirements, Mobile Interaction designs, UX design.
UNIT-3	**Design Patterns and Architectural Consideration:**Recent Trends in Software Design with a special focus on Mobile Apps Development. The GoF and Evolution of Design Patterns.
UNIT-4	**Pattern-based Design:**Design Patterns with Creational Design Patterns, Structural Design Patterns and Behavioural Design Patterns. Example elaborations of popular patterns with suggested areas of Applications.Recent Trends in Software Architecture: Cloud-Based Architecture, Service-Oriented Architecture etc.

Reference Books:

1.	G. Booch, ***"Object-Oriented Analysis and Design with Applications"*** 2nd Edition, PHI, New Delhi
2.	Ralph Johnson, John Vlissides, Richard Helm, and Erich Gamma,***"Design Patterns"***.

3.	Richard N. Taylor et al., ***"Software Architecture: Foundations, Theory, and Practice"*** John Wiley and Sons.

Name of Program	**M. Tech.**	**Semester – I**	**Year – I**

Course– Name	**Natural Language Processing**
Course– Code	**ITME121**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 2**

Prerequisites:

- Data Structures
- Machine Learning
- Basics of Probability

Course Outcomes:

Students will be able to –

CO-1	justify the various steps necessary for processing natural language
CO-2	suggest appropriate lexical and parsing techniques for a given natural language
CO-3	apply appropriate statistical models for a given natural language application
CO-4	modify existing algorithms to suit any natural language for processing
CO-5	suggest appropriate pre-processing steps essential for the various applications involving natural language processing

Course Contents:

UNIT-1	**Lexical Analysis Lexical Analysis** Regular expression and Automata for string matching - Words and Word Forms - Morphology fundamentals - Morphological Diversity of Indian Languages - Morphology Paradigms - Finite State Machine / Transducers Based Morphology - Automatic Morphology Learning - Parts of Speech - N-gram Models - Hidden Markov Models.
UNIT-2	**Speech Processing Biology of Speech Processing** Place and Manner of Articulation - Word Boundary Detection - Argmax based computations - HMM and Speech Recognition - Text to Speech Synthesis - Rule based-Concatenative based approach.
UNIT-3	**Parsing Theories** Parsing Algorithms – Earley Parser - CYK Parser - Probabilistic Parsing - CYK -

	Resolving attachment and structural ambiguity - Shallow Parsing - Dependency Parsing - Named Entity Recognition - Maximum Entropy Models - Conditional Random Fields.
UNIT-4	**Lexical Knowledge Networks Meaning** Lexical Knowledge Networks - Wordnet Theory - Indian Language Wordnets and Multilingual Dictionaries - Semantic Roles - Word Sense Disambiguation - WSD and Multilinguality - Metaphors - Coreference and Anaphora Resolution.
UNIT-5	**Applications** Sentiment Analysis - Text Entailment - Machine Translation - Question Answering System - Information Retrieval - Information Extraction - Cross Lingual Information Retrieval (CLIR).

Reference Books:

1.	"**Speech and Language Processing**" by Daniel Jurafsky and James H. Martin (3rd edition)
2.	Foundations of Statistical Natural Language Processing, Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: May 1999.
3.	"The Oxford Handbook of Computational Linguistics" edited by Ruslan Mitkov
4.	"Introduction to Information Retrieval" by Christopher Manning, Prabhakar Raghavan, and Hinrich Schütze

Name of Program	M. Tech.	Semester – I	Year – I
Course – Name	**Advanced Computer Architecture**		
Course – Code	**IT ME122**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 2**		

Prerequisites:

- Basic knowledge of computer organization and architecture
- Understanding of digital logic design
- Familiarity with programming (preferably in C or assembly language)
- Knowledge of fundamental concepts in operating systems and computer networks

Course Outcomes:

Students will be able to –

CO-1	Understand and articulate advanced computer architecture concepts.
CO-2	Evaluate and optimize various levels of the memory hierarchy.
CO-3	Implement and enhance instruction-level parallelism in processors.
CO-4	Assess and improve thread-level parallelism in shared-memory multicore systems.
CO-5	Develop and optimize data-level parallelism using modern GPU programming techniques

Course Contents:

UNIT-1	**Fundamentals of Advanced Computer Architecture:** Evolution of Computer architecture, system attributes to performance, Multi processors and multi computers, Multi-vector and SIMD computers, PRAM and VLSI models-Parallelism in Programming, conditions for Parallelism-Program Partitioning and Scheduling-program flow Mechanisms-Speed up performance laws-Amdahl‘s law, Gustafson‘s law-Memory bounded speedup Model.
UNIT-2	**Advanced Memory Hierarchy Design:**Memory Hierarchies, Cache Performance Optimization Techniques, Advanced Memory Technologies, Virtual Memory Management, Memory Hierarchy Design Considerations, Tools: Pin Instrumentation and Cachegrind, Case Study: Memory Hierarchies in Modern Processors.

UNIT-3	**Enhancing Instruction Level Parallelism (ILP):**Introduction of ILP, Concepts and Challenges of ILP, Compiler Techniques for ILP, Branch Prediction and Speculation Techniques, Dynamic Scheduling and Out-of-Order Execution, Techniques for Instruction Delivery, Limitations and Challenges of ILP, Tools: Modeling ILP with Pin Tool, Case Study: ILP in Intel Core i7 and ARM Cortex-A8.
UNIT-4	**Advanced Thread Level Parallelism (TLP):**Introduction to TLP, Architectures of Shared-Memory Multicore Systems, Performance Metrics for Multicore Systems, Cache Coherence and Synchronization Protocols, Memory Consistency Models, Multithreaded Programming Techniques using OpenMP, Case Study: TLP in Intel Skylake and IBM Power8.
UNIT-5	**Data Level Parallelism (DLP) and GPUs:**Introduction to DLP, Vector Processing and SIMD Architectures, GPU Architectures and Programming Models, GPU Memory Hierarchy and Optimization Techniques, Detecting and Exploiting Loop-Level Parallelism, CUDA and OpenCL Programming, Case Study: DLP in Nvidia Maxwell and Modern GPUs.

Reference Books:

1.	J.L. Hennessy and D.A. Patterson. ***Computer Architecture: A Quantitative Approach. 5th Edition***, Morgan Kauffmann Publishers, 2012.
2.	Hwang, K.***"Advanced computer architecture with parallel programming"***, McGraw Hill.
3.	J.P. Shen and M.H. Lipasti. ***Modern Processor Design: Fundamentals of Superscalar Processors.*** McGraw-Hill Publishers, 2005.
4.	D.B. Kirk and W.W. Hwu. ***Programming Massively Parallel Processors. 2nd Edition***, Morgan Kauffmann Publishers, 2012.

Name of Program	M. Tech.	Semester – I	Year – I

Course – Name	**Advanced Computer Network**
Course – Code	**ITME123**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 2**

Prerequisites:

- Fundamental of Computer Architecture and Operating System
- Networking

Course Outcomes:

Students will be able to –

CO-1	Understand advanced concepts and next generation networks
CO-2	Analyse TCP/IP variants, network Algorithm's, Protocols and their functionalities
CO-3	Comprehend features of SDN and its application to next generation systems
CO-4	Analyse the performance of various server implementations
CO-5	Understand advanced concepts and next generation networks

Course Contents:

UNIT-1	Packet-Switched Networks, Delay, Loss, and Throughput in Packet-Switched Networks, Protocol Layers and Their Service Models, High Performance Switching and Routing: Introduction, performance considerations, IP address lookup, Algorithms for IP address lookup and optimization, hardware implementation of address lookup.
UNIT-2	**Network Layer:** Network Layer Issues- Routing, Congestion control-Internetworking - Issues, Address Learning Bridges, Spanning tree, Source routing, Bridges, Routers, Gateway.
UNIT-3	Introduction to the Link Layer, Error-Detection and -Correction Techniques, Switched Local Area Networks, Link Virtualization
UNIT-4	Software Defined Network -Comparison between SDN and traditional networks -SDN controller, Switch design, SDN Controller-Switch Protocols, Open Flow Protocol, Control Overhead & Handoff algorithms. Network Function Virtualization -NFV

	Architecture, Use cases, NFV Orchestration and NFV for 5G.
UNIT-5	Cloud Networking, Characteristics of Cloud Networking, Cloud Data Center Networking Topologies, Data Center Networking, Data Center Architectures
Reference Books:	
1.	Larry Peterson and Bruce Davie,***"Computer Networks: A Systems Approach"***,2022.
2.	James F. Kurose and Keith W. Ross, ***"Computer Networking: A Top-Down Approach Featuring the Internet"***, 2023.
3.	Eiji Oki, Roberto Rojas-Cessa, Christian Vogt, ***"Advanced Internet Protocols, Services and Applications"***, John Wiley and Sons Ltd, 2012.
4.	***High Performance Switches and Routers***, H. Jonathan Chao, Bin Liu, 2007, John Wiley & Sons, Inc. ISBN-10: 0-470-05367-4
5.	***Cloud Networking: Understanding Cloud-based Data Centre Networks,*** Gary Lee (Author), Morgan Kaufmann (Publisher), 2014, ISBN-139780128007280

Name of Program	M. Tech.	Semester – I	Year – I
Course – Name	Blockchain Technology		
Course – Code	ITME124		
Course – Periods / Week	(L + T + P) ↔(3 + 1 + 0)		
Course – Exam Scheme	(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)		
Course – Total Marks	150		
Course – Credits	4		
Course – Type	Elective-2		

Prerequisites:

- Basic knowledge of programming
- Data Structures
- Networking
- Web Technology

Course Contents:

UNIT-1	**Fundamental concept of Blockchain Technology:** Origin of blockchain technology, Block Structure, Blockchain Layer Architecture, Blockchain Functional Architecture, Generic Elements of Blockchain, Blockchain infrastructure, Basic concepts of Peer-2-Peer Network, Types of Nodes, Types of Blockchain, Characteristics of Blockchain, Evolution of Blockchain Technology, Bitcoin Cryptocurrency.
UNIT-2	**Cryptography Primer for Blockchain:** Symmetric Cryptography Algorithms, Asymmetric Cryptography Algorithms: RSA, Elliptic Curve Cryptography, Homomorphic Cryptography, Cryptographic Hash Functions, Properties of cryptographic hash functions, SHA-256 hash function, Merkle Trees: Construction of Merkle Trees, Benefits of Merkle Trees, Digital Signatures, Zero-Knowledge Proof.
UNIT-3	**Consensus Algorithms for Blockchain:** Taxonomy of Consensus Algorithms, Proof-Based Consensus Algorithms, Vote-Based Consensus Algorithms, PAXOS consensus algorithm, Byzantine Fault Tolerance-Based Consensus, Practical Byzantine Fault Tolerance (PBFT), Delegated Byzantine Fault Tolerance (DBFT), Federated Byzantine Fault Tolerance (FBFT), Proof of Work (PoW), Proof of Stake (PoS), Hybrid Consensus: Proof-of-Burn (POB), Proof-of-Importance (POI).
UNIT-4	**Fundamentals of Ethereum Blockchain, Smart Contract,** Fundamentals of Solidity Programming**,** Building Blocks of Solidity, Understanding Data Types in Solidity, Control Flow Statements, Functions, Visibility and Modifiers, Inheritance and Libraries, Building a Simple Smart Contract Example.

UNIT-5	**Enterprise Blockchain:** Hyperledger Fabric Platform, Architecture of Hyperledger Fabric, Fundamentals of Tokenization Concept, Non-Fungible Tokens (NFTs), Use cases of Blockchain: E-Governance, Traceability and Anti-Counterfeiting
Reference Books:	
1.	Ambadas Tulajadas Choudhari, A. Sarfarz Ariff, Sham M R, " ***Blockchain for Enterprise Application Developers***", Wiley, 2020.
2.	Bina Ramamurthy "**Blockchain *in action***", Manning Publications, 2020.
3.	Kevin Werbach, ***"The Blockchain and the new architecture of trust"***, MIT Press, 2018.
4.	Joseph J. Bambara and Paul R. Allen, ***"Blockchain – A practical guide to developing business, law, and technology solutions"***, Tata McGraw-Hill Education, 2018.
	Joseph J. Bambara and Paul R. Allen, ***"Blockchain, IoT, and AI: Using the power of three to develop business, technical, and legal solutions"***, TataMcGraw-Hill Education 2019.
5.	Melanie Swan, ***"Blockchain – Blueprint for a new economy"***, OReilly publishers, 2015

Name of Program	M. Tech.	Semester – I	Year – I
Course– Name	Bioinformatics		
Course– Code	ITME125		
Course – Periods / Week	(L + T + P) ↔(3 + 1 + 0)		
Course – Exam Scheme	(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)		
Course – Total Marks	150		
Course – Credits	4		
Course – Type	Elective – 2		

Prerequisites:

- Biostatistics and Probability
- Programming fundamentals
- Basic calculus and linear algebra

Course Outcomes:

Students will be able to –

CO-1	Understand fundamental concepts and terminologies in bioinformatics.
CO-2	Navigate and utilize various biological databases for data retrieval and analysis.
CO-3	Perform sequence alignment (pairwise and multiple) and analyze biological sequences for functional significance.
CO-4	Predict protein structures and interactions using computational tools and algorithms.
CO-5	Apply advanced computational techniques such as HMM and data mining in solving bioinformatics-related problems.

UNIT-1	**Introduction to Bioinformatics and Biological Databases:** Introduction to Bioinformatics: Overview, scope, and significance in biological research, Basic terminologies used in Bioinformatics Biological Databases: Databanks for nucleotides and proteins (GenBank, EMBL, DDBJ), Mapping, sequence, and structure databases, Non-redundant databases and their usage
UNIT-2	Biological Sequence Analysis Genome and Microarray Data Analysis, Pairwise Sequence Alignment: Local and global alignment, Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithms, Gap penalties and scoring matrices (PAM, BLOSUM), Multiple Sequence Alignment (MSA): Progressive alignment (CLUSTAL W), Iterative alignment, Sum-of-pairs method and statistical significance of MSA, BLAST and motif searching

UNIT-3	**Structure Prediction in Proteins Protein Secondary and Tertiary Structure Prediction:** Methods: Homology modeling, threading, and ab initio, Protein folding and stability, Protein subcellular localization, Prediction Tools: OR Finder, PROSITE for motif detection, Structure prediction tools
UNIT-4	**Protein-Protein Interactions and Emerging Areas Protein-Protein Interaction Analysis:** Techniques for detecting and predicting interactions, Databases for protein interaction (e.g., STRING, BioGRID), Emerging Areas in Bioinformatics: Systems biology, Personalized medicine and bioinformatics, Synthetic biology
UNIT-5	**Computational Methods and Data Mining in Bioinformatics Computational Techniques for Sequence and Structure Analysis:** Hidden Markov Models (HMM), Pattern recognition and machine learning approaches, Soft Computing in Bioinformatics: Data mining methods applied to biological data, Use of neural networks and evolutionary algorithms, Applications of bioinformatics in drug discovery and genomics

Reference Books:

1.	Durbin, R., Eddy, S., Krogh, A. &Mitchison, G. (1998). Biological sequence analysis: probabilistic models of proteins and nucleic acids. Cambridge University Press.
2.	Jones, N.C. & Pevzner, P.A. (2004). An introduction to bioinformatics algorithms. MIT Press.
3.	Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
4.	Gibas, C. &Jambeck, P. (2001). Developing Bioinformatics Computer Skills. O'Reilly.
5.	Baxevanis, A. & Ouellette, B. F. F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience.

Name of Program	M. Tech.	Semester – I	Year – I

Course – Name	**Computational Geometry**
Course – Code	**ITME126**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 2**

Course Contents:

UNIT-1	**Randomized Algorithms:** Quicksort, Randomized Quicksort, Expected Running Time Analyses, Quickselect, Randomized Quickselect, Expected, High Probability Bounds, Computational Geometric, Geometric Algorithms, Convex Hulls and Line Segment Intersection, Overlay of Planar Subdivisions and Polygon Triangulation, Delaunay Triangulations, Delaunay triangulations: divide-and-conquer, flip and incremental algorithms, duality of Voronoi diagrams, min-max angle properties.
UNIT-2	**Arrangements and Duality, Polytopes:** Guarding and Triangulations, Partitioning a Polygon into Monotone Pieces, Triangulating a Monotone Polygon, Linear Programming: Half-Plane Intersection, Incremental Linear Programming, Randomized Linear Programming, Unbounded Linear Programs, The Smallest Enclosing Disk Problem, Orthogonal Range Searching: 1-Dimensional Range Searching, Kd-Trees, Range Trees, Higher-Dimensional Range Trees, General Sets of Points, Fractional Cascading,
UNIT-3	**Point Location:** Point Location and Trapezoidal Maps, A Randomized Incremental Algorithm, Dealing with Degenerate Cases, A Tail Estimate, High Dimensional Convex Hulls and Voronoi Diagrams, Geometric Robustness, Binary Space Partitions and Applications, More Geometric Data Structures: Interval Trees, Priority Search Trees, Segment Trees, Binary Space Partitions: The Definition of BSP Trees, BSP Trees and the Painter's Algorithm, Constructing a BSP Tree, The Size of BSP Trees in 3-Space.
UNIT-4	**Arrangements of lines:** arrangements of hyperplanes, zone theorems, many-faces complexity and algorithms; Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, k-sets, polytopes and hierarchies, polytopes and linear programming in d-dimensions, complexity of the union of convex sets, simply connected sets and visible regions.
UNIT-5	Motion Planning and Visibility Graphs, Meshing, Curve and Surface Reconstruction, Sweep techniques: plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements; Randomization in computational geometry: algorithms, techniques for counting; Robust geometric computing; Applications of computational geometry, Range Searching, Clustering

	Point Sets using Quadtrees and Applications, Epsilon-Nets and VC Dimension, Shape Analysis and Shape Comparison.
Reference Books:	
1.	M. de Berg, M. van Kreveld, M. Overmars, and O. Schwarzkopf, ***Computational Geometry, Springer (2008).***
2.	F. P. Preparata and M. I. Shamos. ***Computational Geometry: An Introduction, Springer Verlag (1985)***.
3.	J. O' Rourke, ***Computational Geometry in C,*** Cambridge University Press (1998).
4.	H. Edelsbrunner, ***Algorithms in Combinatorial Geometry,pub: Springer-Verlag Berlin Heidelberg (1987)***
5.	K. Mulmuley, ***Computational Geometry: An Introduction Through Randomized Algorithms,*** Prentice Hall (1994).
6.	Michael J. Laszlo: ***Computational Geometry and Computer Graphics in C' Prentice Hall India (1996)***
7.	Mehlhorn and Naher, LEDA - ***a platform for combinatorial and geometric computing, pub: Cambridge (1999).***
	J. O'Rourke, ***Art Gallery Theorems and Algorithms,*** Oxford Univ. Press (1987).
8.	S.L. Devadoss and J. O'Rourke, ***Discrete and Computational Geometry, Princeton University Press (2011).***

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Department of Information Technology

MTech (IT) SEMESTER: II (New Scheme & Syllabus)

S.No.	Board of Studies	Sub. Code	Subject Name	Periods/week			Examination Scheme					Total Marks	Credits
				L	T	P	TA	FE	SE	ESE	Pract. ESE		
1	Information Technology	IT MC201	Internet of Things	4	0	-	20	15	15	100	-	150	4
2	Information Technology	IT MC202	Big Data analytics	4	0	-	20	15	15	100	-	150	4
3	Information Technology	IT ME23X	Elective-3	4	0	-	20	15	15	100	-	150	4
4	Information Technology	IT ME24X	Elective-4	4	0	-	20	15	15	100	-	150	4
5	Information Technology	IT ME25X	Elective-5	4	0	-	20	15	15	100	-	150	4
6	Information Technology	IT ML201	Lab 3 (IoT Lab)	-	-	3	75	-	-		50	125	2
7	Information Technology	IT ML202	Lab 4 (Optimization Lab)	-	-	3	75	-	-		50	125	2
				20	**0**	**6**	**250**	**75**	**75**	**500**	**100**	**1000**	**24**

S.No.	Elective-3	Elective-4	Elective-5
1	Next Generation Network	Foundations of Information Security	Advanced Optimization Technique
2	Computer Vision	High Performance Computing	Information Retrieval System
3	Cellular and Mobile Computing	Process Mining	Digital and Cyber Forensics
4	5G Networks	Robotics and Automation	Quantum Machine Learning
5	Wireless sensor networks	Agile Software Development	Text Mining
6	Social network analysis	Cloud and IoT Security	Pattern Recognition

Name of Program	M. Tech.	Semester – II	Year – I
Course – Name	Internet of Things		
Course – Code	ITMC201		
Course – Periods / Week	(L + T + P) ↔(3 + 1 + 0)		
Course – Exam Scheme	(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)		
Course – Total Marks	150		
Course – Credits	4		
Course – Type	Core		

Prerequisites:

- Operating System
- Basic Computer Networking Concept

Course Outcomes:

Students will be able to –	
CO-1	Explain the concept of IoT.
CO-2	Analyze various protocols for IoT.
CO-3	Design a PoC of an IoT system using Rasperry Pi/Arduino
CO-4	Apply data analytics and use cloud offerings related to IoT.
CO-5	Analyze applications of IoT in real time scenario.

Course Contents:

UNIT-1	**Enabling Technologies of IoT:**Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects
UNIT-2	**Fundamental Protocols for IoT network:** IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory

	Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT
UNIT-3	**IoT System Design and Development:** Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.
UNIT-4	**IoT Data Analytics and Supporting Services:**Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine/Deep Learning in IoT Analytics, No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework: Django, AWS for IoT – System Management with NETCONF-YANG
UNIT-5	**Case Studies/Industrial Applications:**Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture,Smart Lighting, Smart Parking Architecture and Smart Traffic Control
Reference Books:	
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —***IoT Fundamentals:Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017***
2.	Arshdeep Bahga, Vijay Madisetti, —***Internet of Things – A hands-on approach, Universities Press, 2015***
3.	Olivier Hersent, David Boswarthick, Omar Elloumi , —***The Internet of Things – Key applications andProtocols, Wiley, 2012***
4.	Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David
5.	Boyle, ***“From Machine-to-Machine to the Internet of Things – Introduction to a New Age ofIntelligence”, Elsevier, 2014.***
6.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —***Architecting the Internet of Things,Springer, 2011.***
7.	Michael Margolis, Arduino Cookbook, ***Recipes to Begin, Expand, and Enhance Your Projects, 2ndEdition, O’Reilly Media, 2011.***

Name of Program	M. Tech.	Semester – II	Year – I

Course– Name	**Big Data Analytics**
Course– Code	**IT ME251**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 5**

Course Outcomes:

Students will be able to –

CO-1	Describe big data and use cases from selected business domains
CO-2	List the components of Hadoop and Hadoop Eco-System
CO-3	Access and Process Data on Distributed File System
CO-4	Manage Job Execution in the Hadoop Environment
CO-5	Develop Big Data Solutions using the Hadoop Eco System

Course Contents:

UNIT-1	**Introduction to Big Data:** Definition and characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Importance and applications of Big Data, Challenges in Big Data, Overview of the Hadoop ecosystem, Introduction to MapReduce, Hadoop Distributed File System (HDFS), Applications of Big Data.
UNIT-2	**Data Processing Frameworks**Apache Spark fundamentals, Spark vs. Hadoop, Spark SQL, Spark Streaming, Data collection methods, Data cleaning and preprocessing, ETL tools (e.g., Apache NiFi, Talend)
UNIT-3	**Big Data Analytics Methods:** Descriptive analytics, Data visualization tools and techniques, Exploratory Data Analysis (EDA), Predictive Analytics, Machine learning basics, Common algorithms (e.g., linear regression, decision trees, clustering, Deep learning overview, Neural networks, Use cases in Big Data, Stream processing concepts, Tools for real-time analytics (e.g., Apache Kafka, Apache Storm, Flink).
UNIT-4	**Big Data Security and Privacy:** Data security challenges in Big Data, Privacy-preserving techniques, Legal and ethical considerations.

Reference Books:	
1.	Nathan Marz and James Warren**,** “Big Data: Principles and Best Practices of Scalable Real-Time Data Systems"
2.	Tom White, “Hadoop: The Definitive Guide"
3.	Foster Provost and Tom Fawcett, “Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking"
4.	Martin Kleppmann,"Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems"
5.	Ian Goodfellow, Yoshua Bengio, and Aaron Courville,"Deep Learning".

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Next Generation Networks**		
Course– Code	**ITME231**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 3**		

Prerequisites:

- Computer Networks
- Internet of Things

Course Outcomes:

Students will be able to –	
CO-1	To understand the concept of basic cellular system.
CO-2	To know the types of channel coding techniques, data transmission modes and services of GSM, CDMA.
CO-3	To have an insight into the various propagation models used in mobile communication.
CO-4	To study the recent trends adopted in cellular systems and wireless standards.
CO-5	To understand the concept of basic cellular system.

Course Contents:

UNIT-1	**Next Generation Network:** Principles and definition of an NGN, The NGN architecture, Outline of technology choices, Network and implementation issues with NGN, Numbering & Addressing.
UNIT-2	**The Cellular Network Concept:** System Design Cellular system, Hexagonal geometry cell and concept of frequency reuse, Channel , Soft handoff, hard handoff ,Handoff Strategies, Channel assignment strategies, Large scale path loss:-Free Space Propagation loss equation, Pathloss of NLOS and LOS systems, , Outdoor propagation model, Indoor propagation models.

UNIT-3	**UMTS Terrestrial Radio Access Network:** 2G, 2G Transition, IMT 2000, 3G transition, IMT Advance, 5G.
UNIT-4	**Transition from 3G to 4G:** Transition from 3G to 4G, Long Term Evolution, Architecture of LTE, System Architecture Evolution, Evolve Packet Core, E-UTRAN, Roaming Architecture, communication protocol
UNIT-5	**5G architecture:** 5G architecture, Propagation Channel models for 5G, Device to device communication, Software defined radio networks, 5G for Massive Machine Type Communication and Massive IoT- V2X Communication.

Reference Books:	
1.	Saad Z. Asif, "5G Mobile Communications Concepts and Technologies, CRC Press, 1st Edition, 2019.
2.	Erik Dahlman, Stefan Parkvall, Johan Skold "5G NR: The Next Generation Wireless Access Technology", Academic Press, 1st Edition, 2018.
3.	Jonathan Rodriguez, "Fundamentals 5G Mobile Networks", John Wiley & Sons, 1st Edition, 2015.
4.	Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang, "Massive MIMO in 5G Networks: Selected Applications", Springer, 1st Edition, 2018.
5.	Robert W. Heath Jr., Angel Lozano, "Foundations of MIMO Communication", Cambridge University Press, 1st Edition, 2019.
6.	R. Vannithamby and S. Talwar, "Towards 5G: Applications, Requirements and Candidate Technologies", John Willey & Sons, 1st Edition, 2017

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	Computer Vision		
Course– Code	ITME232		
Course – Periods / Week	(L + T + P) ↔(3 + 1 + 0)		
Course – Exam Scheme	(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)		
Course – Total Marks	150		
Course – Credits	4		
Course – Type	Elective – 3		

Prerequisites:

- Knowledge in Image Processing
- Coordinate Geometry
- Analysis of Algorithms
- Fundamentals of Matrix and Algebra
- Probability and Statistics is desired

Course Outcomes:

Students will be able to –

CO-1	Understand, use, design or specify basic image processing and computer vision algorithms in the context of a complete application
CO-2	Conduct independent study and analysis of image processing and computer vision problems and techniques
CO-3	Get broad exposure to understand of various applications of computer vision in industry, medicine, and defence
CO-4	Explore a range of practical techniques, by developing their own simple processing functionsby using library facilities and tools such as Matlab and Open CV
CO-5	Understand, use, design or specify basic image processing and computer vision algorithms in the context of a complete application

Course Contents:

UNIT-1	**Digital Image Formation and low-level processing:** Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing

UNIT-2	**Depth estimation and multi-camera views:** Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration, Two-view structure from motion, Object detection and tracking.
UNIT-3	**Image Descriptors and Features:** Object Recognition, Boundary and Regional Descriptors, Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters, Gray level cooccurrence matrix, local binary pattern and DWT.
UNIT-4	**Detection, Segmentation, Visualizing and understanding:** CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN, Visualizing CNN features DeepDream, Style Transfer, GAN overview, semantic image synthesis
UNIT-5	**Applications to computer vision:** Motion estimation and object tracking, medical image segmentation and classification, image fusion, visual surveillance, activity, and action recognition, person-reidentification, gesture recognition

Reference Books:	
1.	E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
2.	Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer 2012
3.	R.C. Gonzalez, R.E. Woods, Digital Image Processing, 3rd Edition, Pearson Education
4.	Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision‖, Third Edition, Academic Press, 2012.
5.	D. L. Baggio, Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing, 2012.
6.	R C Gonzalez, Woods and Eddins, Digital Image Processing using Matlab, 2nd Edition, Tata McGraw Hill

Name of Program	M. Tech.	Semester – II	Year – I

Course– Name	**Cellular and Mobile Computing**
Course– Code	**ITME233**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 3**

Prerequisites:

- Computer Networks
- Internet of Things

Course Outcomes:

Students will be able to –

CO-1	To understand the concept of basic cellular system.
CO-2	To know the types of channel coding techniques, data transmission modes and services of GSM, CDMA.
CO-3	To have an insight into the various propagation models used in mobile communication.
CO-4	To study the recent trends adopted in cellular systems and wireless standards.
CO-5	To understand the concept of basic cellular system.

Course Contents:

UNIT-1	**Introduction to Wireless Network System:** Evolution of mobile communications, Mobile Radio System around the world, Types of Wireless communication System, Comparison of Common wireless system, Trend in Cellular radio and personal communication. Second generation Cellular Networks, Adhoc Networks, Sensor Networks, Third Generation (3G) Wireless Networks.
UNIT-2	**The Cellular Network Concept:** System Design Cellular system, Hexagonal geometry cell and concept of frequency reuse, Channel , Soft handoff, hard handoff ,Handoff Strategies, Channel assignment strategies, Large scale path loss:-Free Space Propagation loss equation, Pathloss of NLOS and LOS systems, , Outdoor propagation

	model, Indoor propagation models
UNIT-3	**Wireless LAN Introduction:** WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security, IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX
UNIT-4	**Mobile computing Data management:** Mobile computing Data management issues, data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations, Mobile Agents computing, security and fault tolerance, transaction processing in mobile computing environment.
UNIT-5	**3G And 4G Wireless Standards:** : GSM, GPRS, WCDMA, LTE, WiMax, Simulations of Wireless Networks (OPNET, NS2)
Reference Books:	
1.	Jochen Schiller, Mobile Communications, Addison Wesley.
2.	Asha Mehrotra, GSM System Engineering, Artech House Publishers.
3.	M. V. D. Heijden, M. Taylor, Understanding WAP, Artech House Publishers.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**5G Networks**		
Course– Code	**ITME234**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 3**		

Prerequisites:

- Computer Networks
- Internet of Things

Course Outcomes:

Students will be able to –

CO-1	To understand the concept of basic cellular system and modern cellular communication.
CO-2	To understand the 5G architecture.
CO-3	To understand radio access networks, Device to Device communication.

Course Contents:

UNIT-1	**Introduction:** Introduction and fundamentals of wireless communications: evolution of cellular systemsrequirements, goals, and vision of the next generation wireless communication systems fading, digital modulations, performance metrics. 1G, 2G, 3G and 4G(LTE) overview- Introduction to 5G – Use Cases - Evolving LTE to 5G Capability- 5G NR and 5G core network (5GCN) - 5G Standardization -Challenges and Applications.
UNIT-2	**The 5G architecture:** Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, , Integration of LTE and new air interface to fulfil 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment.
UNIT-3	**Device-to-device (D2D) communications** : D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in 5G: research challenges, Radio resource

	management for mobile broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-hop D2D communications for proximity and emergency, services, , Device discovery without and with network assistance.
UNIT-4	**The 5G radio-access technologies**: Multiple access technology, Orthogonal multiple-access systems, Spread spectrum multipleaccess systems, Capacity limits of multiple-access methods,), Radio access for dense deployments, OFDM numerology for small-cell deployments, Small-cell sub-frame structure, , Radio access for massive machine type communication, , Interference management in 5G, Interference management in UDN

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Wireless Sensor Networks**		
Course– Code	**IT ME235**		
Course – Periods / Week	**(L + T + P) ↔(3+ 1 + 0)**		
Course – Exam Scheme	**(TA + FE +SE+ ESE) ↔(20 + 15+ 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective - 3**		

Course Outcomes:

Students will be able to –	
CO-1	Understand the basics of Wireless Sensor Networks, architecture, applications, issues pertaining to sensor networks and the challenges involved in managing a sensor network.
CO-2	Contribute appropriate algorithms to improve existing or to develop new wireless sensor network applications.
CO-3	Design a fault-tolerant and energy-efficient routing protocol.
CO-4	Explore and implement solutions to real world problems using sensor devices, enumerating its principles of working

Course Contents:

UNIT-1	**Introduction to Sensor Networks :** Key definitions of sensor networks, unique constraints and challenges, advantages of sensor network, driving applications, issues in design of sensor network, sensor network architecture, data dissemination and gathering, Brief Historical Survey of Sensor Networks, and Background of Sensor Network Technology, Applications of Wireless Sensor Networks.
UNIT-2	**MAC Protocols**: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.
UNIT-3	**Routing Protocols:** Routing Protocols for Wireless Sensor Networks, Data Dissemination and Gathering, Routing Challenges and Design Issues, Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data

	Models, Routing Strategies: WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Geographical Routing, Directed Diffusion.
UNIT-4	**QoS and Energy Management:** QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.
UNIT-5	**Localization and Introduction to Simulators:** Localization and positioning, Coverage and connectivity, Single-hop and multi-hop localization, self-configuring localization systems, sensor management. Introduction to Simulation environment-Cooja Simulator, Programming, Glomosim, Qualnet, Case study of Wireless Sensor Network applications.

Reference Books:	
1.	Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Network, John Wiley and Sons, 2005 (ISBN: 978-0-470-09511-9).
2.	Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, Wireless Sensor Network, Springer, 1st Ed. 2004 (ISBN: 978-4020-7883-5).
3.	Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.
4.	Kazem, Sohraby, Daniel Minoli, Taieb Zanti, Wireless Sensor Network: Technology, Protocols and Application, John Wiley and Sons, 1st Ed., 2007 (ISBN: 978-0-471-74300-2).

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**SOCIAL NETWORK ANALYSIS**		
Course– Code	**ITME236**		
Course – Periods / Week	**(L + T + P) ↔(3+ 1 + 0)**		
Course – Exam Scheme	**(TA + FE +SE+ ESE) ↔(20 + 15+ 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective - 3**		

Course Outcomes:

Students will be able to –

CO-1	Describe about the current web development and emergence of social web.
CO-2	Design modelling, aggregating and knowledge representation of semantic web.
CO-3	Summarize knowledge on extraction and analysing of social web.
CO-4	Describe Association rule mining algorithms.
CO-5	Recognize the evolution of social networks.

Course Contents:

UNIT-1	**Introduction to Semantic Web:** Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis, Key concepts and measures in network analysis.
UNIT-2	**Modelling, Aggregating and Knowledge Representation**:Ontology and their role in the Semantic Web: Ontology-based knowledge Representation, Ontology

	languages for the Semantic Web, Resource Description Framework, Web Ontology Language, Modelling and aggregating social network data, State-of-the-art in network data representation, Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data, Advanced representations.
UNIT-3	**Algorithms and Techniques:** Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighboring, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks, the Evolution of Social Networks.
UNIT-4	**Extracting and Analyzing Web Social Networks:** Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and Their Evolutions in Dynamic Networks.
UNIT-5	**Web Mining and Recommendation Systems:** User-based and Item-based Collaborative Filtering Recommender Systems, Hybrid User-based and Item-based Web Recommendation System, User Profiling for Web Recommendation Based on PLSA and LDA Model, Combing Long-Term Web Achieves and Logs for Web Query Recommendation.

Reference Books:

1.	Peter Mika, “Social networks and the Semantic Web”, Springer, 2007.
2.	Guandong Xu,Yanchun Zhang, and Lin Li, “Web Mining and Social Networking Techniques andApplications”, First Edition Springer, 2011
3.	Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.
4.	Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, “Collaborative and Social InformationRetrieval and Access: Techniques for Improved User Modelling”, IGI Global Snippet, 2009.
5.	Charu C. Aggarwal, “Social Network Data Analytics”, Springer; 2011.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Foundations of Information Security**		
Course– Code	**ITME241**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE +SE+ ESE) ↔(20 + 15+ 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective - 4**		

Course Outcomes:

Students will be able to –

CO-1	To understand the basic principles of Security.
CO-2	To understand the basic concepts of the technical components involved in implementing of the security & privacy.
CO-3	Classify and analyse different cryptographic techniques.
CO-4	Select appropriate network protocols for securing data in transit.

Course Contents:

UNIT-1	**Introduction to Information Security and Privacy**: Review of the essential terminologies, basic concepts of security and privacy. Taxonomy of Security attacks. Introductory Topics: Historical Ciphers - Monoalphabetic and polyalphabetic ciphers. Substitution cipher, Transposition cipher.
UNIT-2	**Important Ciphers and their Working**: Stream and block ciphers, modern block cipher, block ciphers principles, shannon's theory of confusion and diffusion, fiestal structure, data encryption standard, strength of DES, block cipher modes of operations, triple DES. Overview of number theory concepts for cryptography, Modern Cryptography: Symmetric vs. asymmetric cryptography, Encryption algorithms: AES, RSA
UNIT-3	**Cryptographic Tools:** The Public-Key-Infrastructure (PKI), Digital Signatures, Digital Certificates, Hybrid Cryptographic Systems, Steganography. The Public Key

	Cryptography (PKC) limitations and looking beyond the PKC. Authentication protocols: Kerberos, OAuth Cryptographic hash functions
UNIT-4	**Protocols for Secure Communications**: HTTPS, SSL/ TLS for Secure Internet Communication, Secure Email, WEP and WPA for Secure Wireless Communications.
UNIT-5	Firewalls, Virtual Private Networks. Intrusion Detection and Prevention Systems. Access control models and mechanisms. Emerging Trends and Practical Applications: Homomorphic encryption, Secure multi-party computation, Blockchain and Cryptocurrency.

Reference Books:	
1.	Bernard Menezes, Network Security and Cryptography, Cengage Learning, fifth edition, 2010.
2.	Behrouz A. Frouzan, Cryptography and Network Security, TMH Publication, third edition,
3.	Whitman and Mattord, *Principles of Information Security*, Cengage Learning, 2006
4.	William Stallings, "Cryptography and Network security Principles and Practices", Pearson/PHI, 4th ed, 2006.
5.	Atul Kahate, Cryptography and Network Security, TMH, third edition, 2008.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**High Performance Computing**		
Course– Code	**IT ME242**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective - 4**		

Course Contents:	
UNIT-1	**Introduction to Parallel Programming** Era of Computing, Parallel Computing, Multiprocessors and Multicomputer Architectures, Scalar VS Vector Processing, Multivector and Superscalar Machines, Pipelined Processors, SIMD and MIMD architectures, Conditions of parallelism, Program flow mechanisms, Types of Parallelism – ILP, PLP, LLP, Program Partitioning and scheduling. Overview of the MPI standard. Point-to-point communication operations. Synchronous and asynchronous modes of data transmission. Case studies: matrix computations, solving partial differential equations using OpenMP and MPI.
UNIT-2	**Introduction to Parallel Algorithms**: Basic Parallel Algorithmic Techniques: Divide-and-Conquer, Partitioning, pipelining, Accelerated Cascading, Symmetry Breaking, Synchronization (Locked, Lock-free) Parallel Algorithms and Data organization for shared/distributed memory, Min/Max, Sum Searching, Merging, Sorting, Various Parallel Sorting and Sorting Networks, Multiprocessor architecture: taxonomy of parallel architectures. Centralized shared-memory architecture, Distributed shared-memory architecture, Non von Neumann architectures.
UNIT-3	**Introduction to High Performance Computing:** Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi,

	Cell BE; Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management.
UNIT-4	**High Speed Networks & Message Passing:**Introduction to High-Speed Networks, Lightweight Messaging Systems, Xpress Transport Protocol, Software RAID and Parallel File systems, Load Balancing Over Networks – Algorithms and Applications, Job Scheduling approaches and Resource Management in Cluster.
UNIT-5	**Introduction toCUDA Programming:** Introduction to CUDA architecture for parallel processing, CUDA Parallelism Model, Foundations of Shared Memory, Introduction to CUDA-C, Parallel programming in CUDA-C, Thread Cooperation and Execution Efficiency, Constants memory and events, memory management, CUDA C on multiple GPUs, Hashing and Natural Parallelism, Scheduling and Work Distribution, Atomics, Barriers and Progress, Transactional Memory, Hybrid parallel programming models (MPI + OpenMP, MPI + CUDA, etc.). Case studies of exascale computing applications.

Reference Books:	
1.	Jean Loup Baer, Microprocessor Architecture, Cambridge University Press (2009).
2.	P. S. Pacheco, An Introduction to Parallel Programming, Elsevier (2011).
3.	M. Quinn, Parallel Programming in C and OpenMP, McCraw Hill Education (India) (2003).
4.	A. Grama, A. Gupta, G. Karypis, and V. Kumar, Introduction to Parallel Computing, Pearson (2007).
5.	J. Joseph & C. Fellenstien, Grid Computing, Pearson Education (2004).
6.	John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach . Elsevier India Pvt. Ltd. (2010).
7.	Georg Hager and Gerhard Wellein. Introduction to High Performance Computing for Scientists and Engineers, CRC Press (2011).
8.	G. Zaccone. Python Parallel Programming Cookbook, Packt Publ. (2015).
9.	Milos Prvulovic, HPCA Course, Georgia Tech. https://www.udacity.com/course/high-performance-computer-architecture--ud007
10.	D. A. Patterson and J. L. Hennessy, Computer Organization and Design 4th Ed, Elsevier Science (2009).
11.	Berhooz Parhami, Computer Architecture, Oxford University Press (2005).

Name of Program	**M. Tech.**	**Semester – II**	**Year – I**

Course– Name	**Agile Software Development**
Course– Code	**ITME245**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective - 4**

Course Outcomes:

Students will be able to –

CO-1	Interpret the concept of agile software engineering and its advantages in software development.
CO-2	Analyse the core practices behind several specific agile methodologies.
CO-3	Access implications of functional testing, unit testing, and continuous integration.
CO-4	Determine the role of design principles in agile software design.
CO-5	Make use of various tools available to agile teams to facilitate the project

Prerequisites:	Software Engineering fundamentals

Course Contents:

UNIT-1	**Fundamentals of Agile:** Need of Agile software development, agile context–Manifesto, Principles, Methods, Values, Roles, Artifacts, Stakeholders, and Challenges. Business benefits of software agility.
UNIT-2	**Planning and Design:** Recognizing the structure of an agile team–Programmers, Managers, Customers. User stories– Definition, Characteristics and content. Estimation– Planning poker, Prioritizing, and selecting user stories with the customer, projecting team velocity for releases and iterations. **Project Design:** Fundamentals, Design principles–Single responsibility, Open-

	closed, Liskov substitution, Dependency-inversion, Interface-segregation.
UNIT-3	**Sensors, Actuators & Controls**: Sensor classifications, Characteristics of Sensors, Various Internal and External Sensors. Characteristics of Actuators, Pneumatic, Hydraulic and Electrical Actuators. Transfer Function, Sequence Control, Servo motor operation and control, PID Controller Design, Regulation of Robotic Manipulators, Intelligent Control.
UNIT-4	Design Methodologies: Need of scrum, Scrum practices –Working of scrum, Project velocity, Burn down chart, Sprint backlog, Sprint planning and retrospective, Daily scrum, Scrum roles– Product Owner, Scrum Master, Scrum Team. Extreme Programming- Core principles, values and practices. Kanban, Feature-driven development, Lean software development.
TextBooks:	
1.	Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, International Edition, Pearson.
2.	Robert C. Martin, “Agile Software Development, Principles, Patterns and Practices”, First International Edition, Prentice Hall.
3.	Lisa Crispin, Janet Gregory, “Agile Testing: A Practical Guide for Testers and Agile Teams”, International edition, Addison Wesley.
4.	Alistair Cockburn, “Agile Software Development: The Cooperative Game”, 2nd Edition, Addison-Wesley
5.	Anis Koubaa et. al., Robot Path Planning and Cooperation Foundations, Algorithms and Experimentations, Springer Cham, 2018.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Cloud and IoT Security**		
Course– Code	**IT ME246**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 4**		

Course Contents:	
UNIT-1	**Fundamentals of Cloud Computing and Deployment Models:** Fundamentals of Cloud Computing: Introduction to cloud computing, Architectural characteristics of cloud computing, Cloud Deployment Models: Public Cloud, Private Cloud, Community Cloud, Hybrid Cloud, Scope of control in different models, Cloud Service Models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS), Cloud Computing Roles and Risks : Roles in cloud computing, Security risks and mitigation
UNIT-2	**Cloud Security and IoT Security:** Cloud security models and frameworks, Secure cloud infrastructure design, Identity and access management in the cloud, Encryption and key management for cloud data, Monitoring and logging in cloud environments, Compliance and regulatory requirements for cloud services. IoT security architecture and design principles, Secure IoT device lifecycle management, Secure communication protocols for IoT, Embedded systems security for IoT devices, IoT network security and segmentation, IoT data security and privacy

UNIT-3	**Secure Software Development:** Secure coding principles and techniques, Application security testing and vulnerability assessment, Secure DevOps and DevSecOps practices, Threat modeling and risk assessment, Secure software design patterns, Secure coding for cloud and IoT platformsCyber risk assessment and management frameworks, Threat intelligence and risk modeling, Incident response and disaster recovery planning, Compliance and regulatory requirements, Cybersecurity insurance and risk transfer, Organizational cybersecurity governance
UNIT-4	**IoT Communication with Cloud and Security:** IoT to Cloud Communication Protocols: Overview of communication protocols used in IoT systems to connect with cloud services, Comparison of protocols such as MQTT, CoAP, and HTTP/HTTPS in terms of efficiency and security.Secure Data Transmission: Encryption techniques (e.g., AES, RSA) used to secure data transmitted between IoT devices and the cloud., Importance of end-to-end encryption and key management practices in ensuring data confidentiality. Authentication and Authorization: Methods for authenticating IoT devices to cloud platforms., Role-based access control (RBAC) and policy management to enforce authorized access to IoT data.Data Integrity and Validation: Techniques for ensuring the integrity of data transmitted over IoT networks, Validation mechanisms to detect and mitigate data tampering or corruption.,
UNIT-5	**Advanced IoT Security and Networking:** device/user authentication, IoT networking protocols, and real-time communication security.Introduction to authentication techniques for IoT devices, securing lower and higher layers of IoT communication, and ensuring data trustworthiness and bandwidth efficiency.Case Study: IoT Solutions with Rubber Pie and Arduino. Rubbery Pie, a fictional IoT device, integrates sensors and actuators to monitor and control industrial processes. Arduino-based IoT systems are widely used in various applications, from smart home automation to environmental monitoring.

Reference Books:

1.	Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi**, Mastering Cloud Computing: Foundations and Applications Programming,Morgan Kaufmann, 2013**
2.	Tim Mather, Subra Kumaraswamy, and Shahed Latif, **Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance,** O'Reilly Media,2009
3.	John R. Vacca**, Cloud Computing Security: Foundations and Challenges,** CRC Press, **2016**
4.	B. Russell and D. Van Duren, Practical Internet of Things Security, Packt Publishing, 2016.
5.	FeiHU, Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and

	Implementations, CRC Press, 2016.
6.	Narayanan et al., Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, 2016.
7.	David B. Davenport, Hong Lin, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of Things" Publisher: Cisco Press 2017

Name of Program	**M. Tech.**	**Semester – II**	**Year – I**

Course– Name	**Advanced Optimization Technique**
Course– Code	**ITMC202**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**3**
Course – Type	**Core**

Prerequisites:

- Undergraduate mathematics: Theory of sets
- Relations and functions
- Linear algebra
- Logic and proof techniques
- Basic knowledge of computer programming

Course Outcomes:

Students will be able to –

CO-1	To cultivate an ability to formulate mathematical model for various complex system occurring in real world applications.
CO-2	To develop knowledge of the mathematical structure of the most commonly used linear and non-linear programming models.
CO-3	To understand the classical optimizations and its applications.
CO-4	Understand the fundamental concepts of meta-heuristics and distinguish between various categories of meta-heuristic optimization techniques.
CO-5	Apply swarm-based, bio-inspired, and nature-inspired optimization techniques to real-world engineering and scientific challenges.

UNIT-1	**Basics of Optimization:** Mathematical formulation (linear and non-linear); Engineering applications of optimization; Classification of optimization problems. Classical optimization (single and multi variable): Optimal criterion for single and multi-variable method; Region elimination methods; Gradient based methods for single variable; Unidirectional search, Direct search methods, Gradient based methods for multi-variable.
UNIT-2	**Constraint Optimization:** problem preparation, Kuhn-Tucker Conditions, Lagrangian Duality Theory, Transformation Methods- Penalty Function Method, Method of Multipliers ; Sensitivity Analysis; Direct Search for Constrained

	Minimization; Linearization methods for constraint problems; Feasible Direction Method; Generalized Reduced Gradient Method and Gradient Projection Method.
UNIT-3	**Goal Programming:** Concept of goal programming, Modeling Multiple objective problems, Goal programming model formulation (Single goal with multiple sub goals, equally ranked multiple goals, Priority ranked goals, General goal programming models), Graphical method of goal programming, Post optimal analysis. 6L Stochastic Programming: Stochastic programming with one objective function. Stochastic linear programming. Two stage programming technique. Chance constrained programming technique. Geometric Programming: Posynomial; Unconstrained GPP using differential Calculus; Unconstrained GPP using Arithmetic – Geometric Inequality; Constrained GPP
UNIT-4	**Metaheuristics Optimization-I** - Introduction to Meta-Heuristics Optimization, Categories of Meta-Heuristic Algorithms, Evolutionary-based Optimization Techniques- Genetic Algorithm (GA), Evolutionary Strategies (ES), Differential Evolution (DE), Working mechanism and applications Case studies of evolutionary algorithms in real-world problems, Swarm-based Optimization Techniques- Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Artificial Bee Colony (ABC)
UNIT-5	**Metaheuristics Optimization-II** - Physics-Based Optimization Techniques-Simulated Annealing (SA), Gravitational Search Algorithm (GSA), Electromagnetism-like Algorithm (EM), Physics-inspired algorithms and real-world examples, Bio-Inspired Optimization Techniques-Grey Wolf Optimizer (GWO), Firefly Algorithm (FA), Cuckoo Search Algorithm (CSA), Nature-Inspired Optimization Techniques-Harmony Search (HS), Flower Pollination Algorithm (FPA), Bat Algorithm (BA), Comparative Analysis of Meta-Heuristic Techniques, ractical Aspects of Optimization
Reference Books:	
1.	S. S. Rao, Engineering Optimization: Theory and Practice, New Age International.
2.	K. Deb, Optimization for Engineering Design, Prentice Hall of India.
3.	A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, Engineering Optimization: Methods and Applications, Wiley.
4.	Metaheuristics - From Design to Implementation: 74 (Wiley Series on Parallel and Distributed Computing)
5.	Swarm Intelligence: From Natural to Artificial Systems Eric Bonabeau, Marco Dorigo, Guy Theraulaz

Name of Program	M. Tech.	Semester – II	Year – I

Course– Name	**Information Retrieval System**
Course– Code	**IT ME252**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 5**

Prerequisites:

- Probability and Statistics
- Programming

Course Outcomes:

Students will be able to –

CO-1	An in-depth understanding of how unstructured texts are processed, indexed, and queried to meet users' information needs.
CO-2	Understanding of different methods for clustering and classifying documents to enhance the efficiency of the retrieval system.
CO-3	Understand the basic concepts of the information retrieval.
CO-4	Understand data pre-processing, indexing, retrieval methods and concepts.
CO-5	Understand how to evaluate the effectiveness and efficiency of different information retrieval.

UNIT-1	**Introduction**:History of IR, Components of IR, Issues, Open source Search engine Frameworks. The impact of the web on IR, role ofartificial intelligence (AI) in IR, IR Versus Web Search, Components of a Search engine. Basic Text Processing: Tokenization, Stopwords, Stemming, Lemmatization, Zipf's and Heap's law, Spelling correction and Edit distances: Hamming distance, Longest common Subsequence, Levenstein edit distance, Boolean Retrieval Model
UNIT-2	**Information Retrieval-I:** Basic Ranking and Evaluation Measures- Vector Space Model, TF*IDF, IR Evaluation: Precision, Recall, F-measures, Mean Reciprocal Rank (MRR), Mean Average Precision (MAP), Normalized Discounted Cumulative Gain (NDCG), designing test collection, relevance judgments, Probabilistic Retrieval Model- Introduction: Generative Model, Probabilistic Ranking Principle, Binary Independence Model, Okapi 25, Bayesian Networks for IR, Statistical Language

	Model-Basics of Language Model, Query-likelihood Approach and different Smoothing Methods, Advance Query Type: Query expansion, Relevance feedback, Novelty & Diversity
UNIT-3	**Information Retrieval-II**: Topic Model- Introduction to topic model, Latent Semantic Indexing, Probabilistic Latent Semantic Indexing, Latent Dirichlet Allocation, Topic model for IR, Link Analysis-Introduction: World Wide Web as Graph, PageRank, HITS, Topic-specific and Personalized PageRank, Indexing and Searching- Different Compression Methods: Ziv-Lempel, Variable-Byte, Gamma, Golomb, Gap encoding, Query Processing: TAAT, DAAT, WAND, Fagin's algorithm, Near Duplicate Detection: Shingling, Min-wise independent permutations, locality sensitive hashing
UNIT-4	**Information Retrieval and Web Search Engine:** Retrieval using unsupervised techniques- Retrieval using word-embeddings and clustering, Retrieval using Supervised ML- Introduction to Learning to Rank for retrieval, Retrieval using classification. Introduction and Crawling,Web search overview, web structure, the user, paid placement, search engine optimization/ spam. Web size measurement, search engine optimization/spam, Web Search Architectures, crawling, meta-crawlers, Focused Crawling, web indexes, Near-duplicate detection, Index Compression, XMLretrieval.
UNIT-5	**Web Search and Specialized Search:**Similarity, Hadoop & Map Reduce - Evaluation, Personalized search, Collaborative filtering and content-based recommendation of documents and products, handling "invisible" Web Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.
Reference Books:	
1.	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze. Introduction to Information Retrieval, Cambridge University Press, 2008. ISBN-13: 978-0521865715 ebook
2.	Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack. Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, ISBN-13: 978-0262026512.
3.	David A. Grossman and OphirFrieder "Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series", 2nd Edition, Springer, 2004.
4.	Jure Leskovec, Anand Rajaraman , Jeffrey D. Ullman. Mining of Massive Datasets, Cambridge University Press, 2011. ISBN: 978-1107077232.
5.	Larry Wasserman. All of Statistics, Springer, 2004. ISBN-13: 978-0387402727

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Digital and Cyber Forensics**		
Course– Code	**ITME253**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 5**		

Prerequisites:

- Operating System
- Data Structures

Course Outcomes:

Students will be able to –

CO-1	To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
CO-2	To understand how to examine digital evidences such as the data acquisition, identification analysis.
CO-3	To understand the basics of mobile phone forensics.
CO-4	To understand the network based cyber security intrusion detection.
CO-5	To know the various forensics tool

Course Contents:

UNIT-1	**Course Introduction:** Introduction to Cyber Forensics, Digital Forensics, Types of Digital Forensics, Forensics Investigation Process,Forensic Protocol for Evidence Acquisition, Digital Forensics Standards and Guidelines
UNIT-2	**Windows Forensic Analysis:** Window artifacts, Evidence volatility, System time, Logged on user(s), Open files, MRUs, Network information, Process information, Service information, Windows Registry, Startup tasks, Memory dumping; Document Forensics: PDF structure, PDF analysis, MSOffice Document structure and analysis, Macros, Windows thumbnails, Android Thumbnails

UNIT-3	**Network Forensics:** Introduction to Network Forensics, Capturing Network Traffic: DHCP Logs, tcpdump/WinDump,Wireshark, SPAN Ports or TAPS, Network-Based Forensics: IDS Overview,Snort Architecture, Snort Preprocessor Component, Snort Detection Engine Component, Network Forensics Evidence Generated with Snort. NetFlow, Using Flow Analytics to Identify Threats within NetFlow, Network Forensic Artifacts, ICMP Attacks, ICMP Sweep Attack, Traceroute Attack, Inverse Mapping Attack, ICMP Smurf Attack.
UNIT-4	**Mobile Network Forensic:** Introduction, Mobile Network Technology, Investigations, Collecting Evidence, Where to seek Digital Data for further Investigations, Interpretation of Digital Evidence on Mobile Network.**Mobile Forensics:** SIM Card, Android architecture, Android File System, Android application, Android SDK, Android Debug Bridge, Memory & SIM acquisition; Virtual Machines, Network Forensics; Cybercrime investigation: Pre investigation, SOP for Investigation; Case scenarios: social media crime, Online defacement crime, Email investigation; CDR Analysis
UNIT-5	**Cloud Forensics:** Introduction to Cloud Forensics, Server-Side Forensics, Client-Side Forensics, Challenges in Cloud Forensics, Artifacts in Cloud Forensics, Use of Cloud Forensics, Forensics as a Service (FaaS), Case Study: Google Drive Investigation, Case Study: Dropbox Investigation, WhatsApp Forensics,Case Study: WhatsApp Database Extraction
Reference Books:	
1.	Kävrestad, Joakim, Marcus Birath, and Nathan L. Clarke. "Fundamentals of Digital Forensics-A Guide to Theory, Research and Applications." *Texts in Computer Science* (2024): 3-267.
2.	Reddy, Niranjan. *Practical cyber forensics*. Apress, 2019.
3.	Lillard, Terrence V. *Digital forensics for network, Internet, and cloud computing: a forensic evidence guide for moving targets and data*. Syngress Publishing, 2010.
4.	Enfinger, Frank, Amelia Phillips, Bill Nelson, and Christopher Steuart. "Guide to computer forensics and investigations." *Boston: Thomson Course Technology* (2005).
5.	Brown, Christopher LT., *"Computer evidence: Collection and preservation",* Charles River Media, Inc., 2009.
6.	Vacca, John R. *Computer forensics: computer crime scene investigation*. Charles River Media, Inc., 2002.
7.	Bunting, Steve and William Wei. EnCase Computer Forensics: The Official EnCE: EnCaseCertifed Examiner Study Guide. Sybex,
8.	Prosise, Chris, Kevin Mandia, and Matt Pepe. *Incident response & computer forensics*. McGraw-Hill, Inc., 2003.
9.	Carrier, Brian. *File system forensic analysis*. Addison-Wesley Professional, 2005.

Name of Program	**M. Tech.**	**Semester – II**	**Year – I**

Course– Name	**Quantum Machine Learning**
Course– Code	**ITME254**
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**
Course – Total Marks	**150**
Course – Credits	**4**
Course – Type	**Elective – 5**

Prerequisites:

- Quantum Computing and Algorithms
- Classical Machine Learning
- Quantum Programming Skills

Course Outcomes:

Students will be able to –

CO-1	Correlatelearned quantum computing principles with machine learning techniques.
CO-2	Analyze key quantum algorithms to solve machine learning problems effectively.
CO-3	Design quantum machine learning models, integrating classical machine learning techniques with quantum computing frameworks.
CO-4	Implement and evaluate the performance of quantum machine learning algorithms,with classical and other quantum algorithms, based onvarious performance factors.
CO-5	Investigate quantum algorithms as effective solutions to solve real-world problems in diversified domains of computational science and technology.

Course Contents:

UNIT-1	**Course Introduction:**Introduction and Overview, Basics of Quantum Computing, Basics of Machine Learning and Algorithms Revision, Quantum-Classical Models.
UNIT-2	**Quantum Structures for Machine Learning:**Foundation for Building Quantum Machine Learning Framework, Quantum Algorithmic Design Strategies Revisited, Basic Concepts of Designing Quantum-Based Machine Learning Algorithms.
UNIT-3	**QuantumMachine Learning Algorithms:**Quantum Regression, Classification, and Clustering Algorithms, Quantum Decision Trees (QDTs), Quantum Support Vector Machines (QSVM), Quantum K-Means, Quantum Principal Component Analysis (QPCA), Quantum Naïve Bayes (QNB), Quantum Pattern Recognition (QPR), Adiabatic Quantum Computing, Variational Quantum Eigen-solver (VQE).

UNIT-4	**Quantum Algorithmic Realization:** Quantum Programming using QuEST, Quirk and IBM Qiskit, Hands-on with **TensorFlow Quantum** (TFQ) Library, Quantum Circuit Development and Realization of Quantum Machine Learning Algorithms.
UNIT-5	**Recent Research Progress:** Significant Research and Development of Quantum Computing in Computer Science, Quantum-Based Machine Learning Applications in Cryptography and Security, Optimization Problems,Bio-Medical Informatics, Healthcare, Data Science and Analytics, Natural Language Processing and etc.

Reference Books:	
1.	Michael A. Nielsen & Isaac L. Chuang,***Quantum Computation and Quantum Information***, 10th Anniversary Edition – 2010, Cambridge University Press.
2.	Peter Wittek, ***Quantum Machine Learning – What Quantum Computing Means to Data Mining***, I Edition – 2014, Elsevier Publication.
3.	Xavier Vasques, ***Machine Learning Theory and Applications: Hands-on Use Cases with Python on Classical and Quantum Machines*****,** First Edition – 2024, Wiley & Sons Publications.
4.	Elias F. Combarro, ***A Practical Guide toQuantum Machine Learningand Quantum Optimization: Hands-on Approach to Modern QuantumAlgorithm*****,** First Edition – 2023, Packt Publishing Ltd.
5.	Dr. Frank Zickert, ***Hands-on Quantum Machine Learning with Python***, First Edition Volume 1 – 2021, PYQML Publication.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	**Text mining**		
Course– Code	**ITME255**		
Course – Periods / Week	**(L + T + P) ↔(3 + 1 + 0)**		
Course – Exam Scheme	**(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)**		
Course – Total Marks	**150**		
Course – Credits	**4**		
Course – Type	**Elective – 5**		

Prerequisites:

- Data Mining
- Machine Learning

Course Outcomes:

Students will be able to –	
CO-1	Understand the basic concepts of text mining.
CO-2	Understand various text categorization and clustering techniques.
CO-3	Understand various topic modeling techniques and its application.
CO-4	Understand concept of document summarization.

Course Contents:

UNIT-1	**Introduction:** Overview, Problem Types, Text vs. Data Mining, Fundamental concepts Natural language processing: Part-of-speech tagging, chunking, syntax parsing and named entity recognition, Document representation: Vector Space Model.
UNIT-2	**Text Categorization:** Basic supervised text categorization algorithms: Decision Tree, Rule-based classifiers Naive Bayes, kNearest Neighbor (kNN) and Logistic Regression,
UNIT-3	**Text Clustering:** connectivity-based clustering and centroid-based clustering algorithms.
UNIT-4	**Topic modelling:** General idea of topic modeling, two basic topic models: ProbabilisticLatent Semantic Indexing (pLSI) and Latent Dirichlet Allocation (LDA), and their variants fordifferent application scenarios, including classification, collaborative filtering, and hierarchicaltopical structure modeling.
UNIT-5	**Document summarization and Sentiment Analysis**

	Document summarization: Extractive and Abstractive summarization. Sentiment Analysis: Coarse-grained and Fine-grained analysis, Machine Learning for Sentiment Analysis. Opinion mining, Opinion lexicon expansion, Text mining applications and case studies.
Reference Books:	
1.	Mining Text Data. Charu C. Aggarwal and ChengXiangZhai, Springer, 2012.
2.	Speech & Language Processing. Dan Jurafsky and James H Martin, Pearson Education India,2000.
3.	Introduction to Information Retrieval. Christopher D. Manning, PrabhakarRaghavan, and HinrichSchuetze, Cambridge University Press, 2007.
4.	Sholom Weiss, Nitin Indurkhya, Tong Zhang, Fred Damerau "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Springer, paperback 2010.
5.	Ronen Feldman, James Sanger -"The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data"-Cambridge University press, 2006.

Name of Program	M. Tech.	Semester – II	Year – I
Course– Name	Pattern Recognition		
Course– Code	IT ME256		
Course – Periods / Week	(L + T + P) ↔(3 + 1 + 0)		
Course – Exam Scheme	(TA + FE + SE + ESE) ↔(20 + 15 + 15 + 100)		
Course – Total Marks	150		
Course – Credits	4		
Course – Type	Elective – 5		

Prerequisites:

- Basics of Probability
- DBMS

Course Outcomes:

Students will be able to –

CO-1	Understand the basic of pattern recognition.
CO-2	Understand various dimensionality reduction techniques.
CO-3	Understand various Supervised Learning techniques.
CO-4	Understand various Unsupervised Learning techniques.

Course Contents:

UNIT-1	**Introduction:** Definitions, data sets for Pattern Recognition, Structure of a typical pattern recognition system. Learning paradigms, Supervised and unsupervised learning, Bayesian decision theory: Minimum error rate classifier; Parameter estimation: Maximum likelihood.
UNIT-2	**Dimensionality Reduction Techniques:** Feature vectors, Feature spaces, Feature selection: class separability measures, Feature Selection Algorithms: Branch and bound algorithm, sequential forward / backward selection algorithms, Features extraction: Principal Component Analysis. Fisher linear discriminate.
UNIT-3	**Pattern Classification:** Naive Bayes classifier, Non-parametric techniques for density

	estimation, Parzen windows, K-nearest neighbours, Hidden Markov models. Perceptron, Support vector machines; Generalization ability of learning methods: Bias and variance, Regularization.
UNIT-4	**Pattern Clustering:** Similarity/dissimilarity measures; clustering criteria, K-means clustering, DBSCAN.
UNIT-5	**Ensemble Techniques:** Bootstrapping, Boosting, Bagging.
Reference Books:	
1.	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
2.	R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
3.	S. Theodoridis and K. Koutroumbas, Pattern Recognition, Academic Press, 2009
4.	E. Alpaydin, Introduction to Machine Learning, Prentice-Hall of India, 2010.
5.	G. James, D. Witten, T. Hastie and R. Tibshirani, Introduction to Statistical Learning, Springer, 2013.