First Year Curriculum

Admission Year 2026-27

Master of Technology
Artificial Intelligence and Data Science

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Semester: 1

Rationale : This course aims to equip students with in-depth knowledge of advanced data structures and algorithmic techniques to solve complex computational problems efficiently. It emphasizes algorithm design paradigms, performance analysis, and practical application in real-world and competitive scenarios.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
3	-	-	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Advanced Data Structures & Algorithm Analysis:**Algorithm analysis, time & space complexity, asymptotic notation, linear & nonlinear data structures, recurrence relations, amortized analysis, randomized algorithms	20	8
2	**Divide and Conquer with Advanced Tree Structures:**Binary search trees, AVL trees, Red-Black trees, B/B+ trees, Merge Sort, Quick Sort, Strassen’s matrix multiplication, Fibonacci & Binomial heaps, k-D trees	15	6
3	**Greedy Algorithms and Their Applications:**Knapsack problem, Job sequencing, Minimum cost spanning trees (Kruskal’s & Prim’s algorithm), Optimal merge patterns, Bin packing problem	15	6
4	**Dynamic Programming and Graph Algorithms:**Shortest path algorithms, 0/1 Knapsack, TSP, Coin Change, Matrix Chain Multiplication, OBST, NP-Hard & NP-Complete problems.	20	8
5	**String Matching and Computational Geometry:**Naïve string matching, Rabin-Karp, Knuth-Morris-Pratt (KMP), Longest Common Subsequence (LCS), Fractional Cascading, Suffix Trees, Geometric Algorithms	15	6
6	**Advanced Graph and Network Flow Algorithms:**Depth-First Search (DFS), Breadth-First Search (BFS), Topological Sorting, Network Flow problems	15	6
	Total	**100**	**40**

Reference Books

1.	**Introduction to Algorithm** By Cormen, Leiserson, Rivest, Stein | PHI (2003) | 2nd Edition
2.	**"Algorithm Design"** By Klein berg and Tardos
3.	**Data Structures and Algorithm Analysis in C++** By Mark Allen Weiss | Pearson | 2nd Edition, Pub. Year 2004
4.	**Fundamentals of Data Structures in C++-** By Sartaj Sahani
5.	**Fundamentals of Computer Algorithms** By E. Horowitz, S. Sahni, and S. Rajsekaran | Galgotia Publication

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Basic ability to analyze algorithms and to determine algorithm correctness and time Efficiency class. 2. Master a variety of advanced abstract data type (ADT) and data structures and their implementations. 3. Master different algorithm design techniques (brute-force, divide and conquer, greedy, etc 4. Ability to apply and implement learned algorithm design techniques and data structures to solve problem. 5. Ability to crawl information and explain different types of search algorithms

Course: MTech

Prerequisite: Fundamentals of Knowledge of Programming.

Rationale : This course aims to equip students with in-depth knowledge of advanced data structures and algorithmic techniques to solve complex computational problems efficiently. It emphasizes algorithm design paradigms, performance analysis, and practical application in real-world and competitive scenarios.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
-	-	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:

1. Construct and Manipulate Tree Structures
2. Work with Heap Data Structures like Min Heap, Max Heap, Binomial & Fibonacci Heaps
3. Apply Graph Algorithms for Problem Solving
4. Solve Problems Using Dynamic Programming
5. Explore Backtracking Algorithms for Constraint Problems

List of Practical

1.	To Implement Stacks and Queues using Arrays and Linked Lists
2.	To Implement Binary Search Trees (BST) and Threaded Trees
3.	To Implement Self-Balancing Trees: AVL Trees & Red-Black Trees
4.	To Implement B-Trees and B+ Trees
5.	To Implement Heap Data Structures: Min Heap, Max Heap, Binomial & Fibonacci Heaps
6.	To Implement Graph Algorithms: DFS, BFS, and Shortest Path Algorithms
7.	To Implement String Matching Algorithms: Naïve, Rabin-Karp, and KMP
8.	To Implement Greedy Algorithms: Kruskal's, Prim's, and Huffman Encoding
9.	To Implement Dynamic Programming Problems: Knapsack, Matrix Chain Multiplication, and LCS
10.	To Implement Backtracking Algorithms: N-Queens, Sudoku Solver, and Hamiltonian Cycle

Course: MTech **Semester:** 1

Prerequisite: Fundamental concepts of Data Structures and Algorithms, Linear Algebra, Probability & Statistics

Rationale : This course is design to Understand fundamental concepts of Machine Learning, different types of learning paradigms, and evaluation techniques, explore regression and classification techniques, including decision trees, SVMs, and probabilistic models.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	-	-	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Machine Learning:**ML Basics: Definitions, Applications, Challenges - Types of Learning (Supervised, Unsupervised, Reinforcement) - Evaluation Metrics (Accuracy, Precision, Recall, F1-score, ROC-AUC) - Bias-Variance Tradeoff - Cross-validation techniques - Data Preprocessing (Normalization, Standardization, Encoding).	**20**	**9**
2	**Regression & Classification Models:**Linear Regression (Simple, Multiple, Polynomial) - Lasso & Ridge Regression - Decision Trees (Gini Index, Entropy, Pruning) - k-Nearest Neighbors (kNN) - Feature Selection & Dimensionality Reduction (PCA, LDA, t-SNE) - Case Study: Predictive Modeling in Finance.	**20**	**9**
3	**Probabilistic & Kernel-Based Models:**Naïve Bayes Classifier - Bayesian Networks - Logistic Regression - Support Vector Machines (SVM) & Kernel Methods - Gaussian Mixture Models (GMM) - Kernel PCA - Python implementation of Bayesian models & SVM.	**20**	**8**
4	**Neural Networks & Deep Learning:**Introduction to Neural Networks - Perceptron & Multi-layer Perceptron (MLP) - Backpropagation Algorithm - Convolutional Neural Networks (CNNs) - Recurrent Neural Networks (RNNs) & LSTMs - Transfer Learning - Introduction to Reinforcement Learning (Q-Learning, Policy Gradient).	**20**	**8**
5	**Advanced Topics & Model Interpretability:**Ensemble Methods (Bagging, Boosting, Random Forest, XGBoost) - Clustering (K-Means, DBSCAN, Hierarchical) - Explainable AI (SHAP, LIME) - Hyperparameter Tuning (Grid Search, Bayesian Optimization) - Model Deployment (Flask, FastAPI) - Research paper discussions.	**20**	**8**
	Total	**100**	**42**

Reference Books

1.	**"Machine Learning: A Probabilistic Perspective" Author: Kevin P. Murphy | Publisher: The MIT Press**
2.	**Christopher M. Bishop, —Pattern Recognition and Machine Learning‖, Springer 2011 Edition.**
3.	**Deep Learning** By Goodfellow, Bengio, and Courville.
4.	**"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" Author: Aurélien Géron | Publisher: O'Reilly Media**

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Understand core concepts of Machine Learning and model evaluation. 2. Apply regression and classification techniques for real-world data. 3. Analyze probabilistic and kernel-based models for decision-making. 4. Implement neural networks and deep learning techniques for complex problems. 5. Explore advanced ML topics, interpret models, and deploy solutions.

Course: MTech **Semester:** 1

Prerequisite: Fundamental concepts of Data Structures and Algorithms, Linear Algebra, Probability & Statistics

Rationale : This course is design to Understand fundamental concepts of Machine Learning, different types of learning paradigms, and evaluation techniques, explore regression and classification techniques, including decision trees, SVMs, and probabilistic models.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
-	-	2	-	1	-	20	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Understand core concepts of Machine Learning and model evaluation.
2. Apply regression and classification techniques for real-world data.
3. Analyze probabilistic and kernel-based models for decision-making.
4. Implement neural networks and deep learning techniques for complex problems.
5. Explore advanced ML topics, interpret models, and deploy solutions.

List of Practical

1.	Basic exercises on Python ML packages (NumPy, Pandas, Matplotlib, Scikit-learn).
2.	Compute Covariance, Correlation Matrix for a given dataset.
3.	Implement Linear Regression and compute residual error.
4.	Implement different distance measures (Euclidean, Manhattan, Cosine) on sample datasets.
5.	Implement Decision Tree (ID3) on a dataset and analyze performance.
6.	Implement k-Nearest Neighbors (kNN) and evaluate accuracy.
7.	Perform Feature Reduction using PCA and visualize transformed features.
8.	Implement Naïve Bayes classifier for text classification.
9.	Implement Support Vector Machine and tune hyperparameters.
10.	Implement Perceptron learning algorithm and evaluate performance.

Course: MTech

Prerequisite: Python, Data Structure, DBMS

Rationale : This course aims to provide a comprehensive understanding of Big Data analytics, real-time processing, and data mining techniques. It focuses on tools like Hadoop, Spark, NoSQL, and the application of machine learning to solve Big Data challenges.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	-	-	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Fundamentals of Big Data and Analytics:**Introduction to Big Data, limitations of traditional systems, characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Big Data storage and processing stack, real-time analytics use cases	**14**	**6**
2	**Streaming Data Processing and Real-Time Analytics:** Stream data concepts, architecture of data streams, data sampling and filtering techniques, sliding window models, event-driven analytics, real-time fraud detection, social media sentiment analysis, stock prediction models	**14**	**6**
3	**Distributed File Systems and Hadoop Ecosystem:**HDFS architecture and internals, Hadoop core components, MapReduce programming, execution workflow, job optimization techniques, failure handling in Hadoop, introduction to cloud-based Hadoop services	**18**	**7**
4	**Big Data Processing with Apache Spark and NoSQL Databases:**Spark ecosystem and its components, Spark vs. Hadoop, RDDs and their transformations, DataFrames and Spark SQL, NoSQL database models (document-based, columnar, graph-based), data analytics with HBase, MongoDB, and Cassandra.	**18**	**7**
5	**Scalable Data Mining and Machine Learning Algorithms:**Graph analytics for Big Data, community detection in large networks, recommendation systems, similarity detection, clustering techniques, frequent pattern mining, machine learning on large datasets	**14**	**6**
6	**Big Data Frameworks, Security, and Ethical Challenges:** Advanced applications using Pig and Hive, data querying with HiveQL, integration of HBase and ZooKeeper, IBM BigInsights and emerging frameworks, Big Data privacy and compliance, ethical AI, data governance, structured vs. semi-structured vs. unstructured data.	**14**	**6**
7	**Recent Trends and Research in Big Data:**Advancements in AI-driven Big Data analytics, federated learning, real-time edge computing, Big Data in IoT and smart cities, quantum computing applications in data science, emerging cloud-based Big Data solutions, future challenges	**8**	**4**
	Total	**100**	**42**

Reference Books

1.	**Hadoop: The Definitive Guide** By Tom White | O’Reilly | 4th Edition, Pub. Year 2015
2.	**Understanding Big data** By Chris Eaton,Dirk derooset al. | McGraw Hill, Pub. Year 2012
3.	**Big data analytics with R and Hadoop** By VigneshPrajapati | SPD, Pub. Year 2013
4.	**Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data.(TextBook) Wiley Publications**

5.	**Hadoop: The Definitive Guide** By Tom White

Course Outcome
After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Acquire the fundamental concepts of big data analytics using Intelligent techniques. 2. To learn how to use various techniques for mining data stream. 3. Map Reduce Concepts implementation in Big data problem. 4. Acquire the knowledge of programming tools and frameworks in Hadoop distributed system. 5. To explore different issues in big data domain.

Course: MTech

Prerequisite: Python, Data Structure, DBMS

Rationale : This course aims to provide a comprehensive understanding of Big Data analytics, real-time processing, and data mining techniques. It focuses on tools like Hadoop, Spark, NoSQL, and the application of machine learning to solve Big Data challenges.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
-	-	2	-	1	-	-	20	-	30	50

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Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Acquire the fundamental concepts of big data analytics using Intelligent techniques.
2. To learn how to use various techniques for mining data stream.
3. Map Reduce Concepts implementation in Big data problem.
4. Acquire the knowledge of programming tools and frameworks in Hadoop distributed system.
5. To explore different issues in big data domain.

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List of Practical

1.	To Perform HDFS Operations and File Management in Hadoop
2.	To Develop and Execute a MapReduce Program for Data Processing
3.	To Implement Real-Time Data Stream Processing using Kafka and Spark Streaming
4.	To Perform Data Preprocessing and Analytics using Apache Pig
5.	To Query and Analyze Large Datasets using Hive and HiveQL
6.	To Work with NoSQL Databases: Implement CRUD Operations in MongoDB and HBase
7.	To Implement Machine Learning Models on Big Data using Spark MLlib
8.	To Build a Scalable Recommendation System using Apache Mahout
9.	To Perform Sentiment Analysis on Twitter Data using Apache Spark
10.	To Explore Recent Trends in Big Data: Implement Federated Learning or Edge Computing

Course: MTech

Prerequisite: Operating Systems, Computer Networks

Rationale : This course introduces the principles and architecture of distributed systems, along with algorithms supporting distributed computing. It provides hands-on experience in designing, analyzing, and implementing modern distributed systems.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	-	-	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Fundamentals of Distributed Systems :**Introduction to Distributed Systems - Characteristics & Types - Architectural Styles - Communication in DS: Remote Procedure Calls, Message-Oriented Middleware, gRPC - Naming and Synchronization - Case Study: Google’s Borg & Kubernetes.	20	8
2	**Synchronization & Coordination :**Logical Clocks - Lamport & Vector Clocks - Leader Election Algorithms (Bully, Ring) - Mutual Exclusion Techniques - Consensus Protocols: Paxos, RAFT - Deadlock Handling & Detection - Coordination Services (Zookeeper, etcd).	20	8
3	**Distributed Storage & Processing :** Distributed File Systems: HDFS, Google File System - Distributed Caching (Redis, Memcached) - Data Consistency Models - Eventual Consistency & CAP Theorem - Distributed Databases (NoSQL, Spanner, DynamoDB) - Big Data Processing (Hadoop, Apache Spark).	20	9
4	**Fault Tolerance & Security :** Fault Models & Recovery Techniques - Replication Strategies - Byzantine Fault Tolerance - Distributed Transactions & 2PC/3PC - Security in DS (Authentication, Encryption) - Blockchain & Smart Contracts.	20	9
5	**Cloud, Edge, and Serverless Computing :**Cloud Computing Models - Serverless Architectures - Microservices & Containerization - Edge & Fog Computing - Case Studies (AWS Lambda, Google Cloud Functions, Azure).	20	8
	Total	**100**	**42**

Reference Books

1.	**Distributed Computing by Ajay Kshemkalyani and Mukesh Singhal**
2.	**Distributed Algorithms** By Nancy A. Lynch | Hardcourt Asia Pvt. Ltd., Morgan Kaufmann, Pub. Year 2000
3.	**Modern Operating System** By Tanenbaum | Prentice Hall
4.	**Distributed Systems Concepts and Design** By George Coulouris, Jean Dollimore and Tim Kindberg | Addison-Wesley Inc./Pearson Education | 4

Course Outcome
After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Explain distributed system principles and architectures. 2. Apply distributed algorithms for synchronization, concurrency, and coordination. 3. Evaluate fault tolerance, recovery mechanisms, and distributed transactions. 4. Analyze distributed storage, databases, and file systems. 5. Develop and implement distributed applications using modern platforms.

Course: MTech

Prerequisite: Operating Systems, Computer Networks

Rationale : This course introduces the principles and architecture of distributed systems, along with algorithms supporting distributed computing. It provides hands-on experience in designing, analyzing, and implementing modern distributed systems.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
-	-	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Explain distributed system principles and architectures.
2. Apply distributed algorithms for synchronization, concurrency, and coordination.
3. Evaluate fault tolerance, recovery mechanisms, and distributed transactions.
4. Analyze distributed storage, databases, and file systems.
5. Develop and implement distributed applications using modern platforms.

List of Practical

1.	**Implementation of Remote Procedure Calls (RPC)** **Tools/Platform:** Python (gRPC), Java (RMI), Postman for testing. **Task:** Develop a simple **RPC-based** communication system between client and server.
2.	**Exploring Kubernetes Cluster Management** **Tools/Platform:** Kubernetes, Docker, Minikube. **Task:** Set up and deploy an application using **Kubernetes** and analyze container orchestration.
3.	**Implementing Logical Clocks (Lamport & Vector Clocks)** **Tools/Platform:** Python, Java, SimPy for simulations. **Task:** Simulate **logical clocks** for event ordering in a distributed system.
4.	**Leader Election Algorithm Simulation** **Tools/Platform:** Python, Java, Network Simulator (NS-3). **Task:** Implement and test **Bully** and **Ring Leader Election** algorithms.
5.	**Consensus Protocols (Paxos & RAFT) Implementation** **Tools/Platform:** Python, Raft-Py, Apache ZooKeeper. **Task:** Simulate distributed **consensus algorithms** and analyze fault tolerance.
6.	**Distributed File System Setup (HDFS/Google File System)** **Tools/Platform:** Apache Hadoop (HDFS), Google Cloud Storage, MinIO. **Task:** Install and configure **Hadoop HDFS** for distributed data storage.
7.	**Big Data Processing with Apache Spark** **Tools/Platform:** Apache Spark, PySpark, Google Colab. **Task:** Run **map-reduce jobs** and perform large-scale data analysis using **Apache Spark**.
8.	**Byzantine Fault Tolerance (BFT) Simulation** **Tools/Platform:** Python, Hyperledger Fabric, Tendermint. **Task:** Implement a **BFT algorithm** to handle malicious nodes in a distributed system.
9.	**Blockchain-Based Secure Transaction System** **Tools/Platform:** Ethereum, Solidity, Ganache, Truffle. **Task:** Develop a simple **blockchain network** for decentralized transaction validation.
10.	**Serverless Computing with AWS Lambda/Google Cloud Functions** **Tools/Platform:** AWS Lambda, Google Cloud Functions, Azure Functions. **Task:** Deploy and test a **serverless function** using AWS Lambda or Google Cloud Functions.

Course: MTech

Prerequisite: Mathematics and Statistics, AI Fundamentals

Semester: 1

Rationale : The objective of this course is to provide students with a fundamental and advanced understanding of Computational Intelligence (CI), covering key techniques, algorithms, and real-world applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	-	-	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Computational Intelligence:**Definition, biological vs. artificial intelligence, neural networks, evolutionary computation, fuzzy logic, myths, historical perspectives, soft computing vs. hard computing, real-world applications.	**15**	**6**
2	**Fundamentals of Artificial Intelligence (AI):**AI concepts, history, types of AI (narrow, general, super AI), machine learning vs. deep learning, AI techniques, knowledge representation, AI adoption in industries.	**15**	**6**
3	**Evolutionary Computation Techniques and Optimization:** Overview of evolutionary computation, genetic algorithms, evolutionary programming and strategies, particle swarm optimization, implementation issues in evolutionary computation.	**15**	**6**
4	**Fundamentals of Neural Networks:** Neural network basics, topologies, adaptation, comparison with other processing methods, stochastic models, regression, Bayes classification, radial basis functions, preprocessing and post-processing techniques.	**15**	**7**
5	**Fuzzy Logic Systems and Control :**Fuzzy sets and fuzzy logic, approximate reasoning, fuzzy controllers, fuzzy rule-based systems, fuzzy logic implementation techniques.	**15**	**6**
6	**Performance Metrics and Computational Intelligence Applications :**Training, testing, and validation, cross-validation, fitness functions, parametric and non-parametric statistics, effectiveness metrics, ROC curves, explanation facilities, case studies on real-world computational intelligence applications.	**15**	**7**
7	**Recent Trends and Research in Computational Intelligence :** Advancements in AI and neural networks, reinforcement learning, hybrid AI models, neuromorphic computing, AI ethics and bias, real-world case studies and future research directions.	**10**	**4**
	Total	**100**	**42**

Reference Books

1.	**Andries P. Engelbrecht, Computational Intelligence - An Introduction, Wiley Publication**
2.	**Computational Intelligence: a logical approach** By David Poole, Alan Mackworth, Randy Goebel | Oxford University Press

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Understand the fundamentals of Computational Intelligence and AI. 2. Apply evolutionary computation methods for solving complex problems. 3. Develop and implement neural network models for data classification and decision-making. 4. Utilize fuzzy logic and reasoning techniques for intelligent control systems. 5. Analyze recent trends and advancements in Computational Intelligence.

Course: MTech

Prerequisite: Fundamental knowledge of Artificial Intelligence

Semester: 1

Rationale : The objective of this course is to provide students with a fundamental and advanced understanding of Computational Intelligence (CI), covering key techniques, algorithms, and real-world applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
-	-	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Implement AI search algorithms, neural networks, and optimization techniques for problem-solving. 2. Develop and apply evolutionary computation methods such as Genetic Algorithms and Particle Swarm Optimization. 3. Design fuzzy logic-based systems for basic decision-making applications. 4. Analyze model performance using evaluation metrics and explore recent research trends in Computational Intelligence.

List of Practical	
1.	**Implementation of Basic AI Search Algorithms (BFS & DFS)**
2.	**Solving Optimization Problems using Genetic Algorithms**
3.	**Implementation of Particle Swarm Optimization (PSO)**
4.	**Design and Training of a Feedforward Neural Network.**
5.	**Developing a Backpropagation Neural Network for Classification.**
6.	**Basic Implementation of Fuzzy Logic Rules using Python**
7.	**Simple Fuzzy System for Weather Prediction**
8.	**Evaluating Model Accuracy using Confusion Matrix**
9.	**Case Study on Hybrid AI Models (Combination of Neural Networks & Fuzzy Systems)**
10.	**Exploring Recent Research Trends in Computational Intelligence (Paper Review & Presentation)**

Course: MTech

Prerequisite: Basic Analytical and analysis skill

Semester: 1

Rationale : The course introduces AI concepts and tools that can be applied to the design process, enabling students to create innovative, efficient, and user-centric designs in various creative domains.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
4	-	-	-	4	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**INTRODUCTION** Research: Definition, Characteristics, Motivation and Objectives, Research Methods vs Methodology, Types of Research — Descriptive vs Analytical, Applied vs Fundamental, Quantitative vs Qualitative, Conceptual vs Empirical.	**10**	**4**
2	**METHODOLOGY** Research Process, Formulating the Research Problem, Defining the Research Problem, Research Questions, Research Methods vs. Research Methodology.	**10**	**4**
3	**LITERATURE REVIEW** Review Concepts and Theories, Identifying and Analyzing the Limitations of Different Approaches	**20**	**6**
4	**FORMULATION AND DESIGN** Concept and Importance in Research, features of a Good Research Design, Exploratory Research Design, Concept, Types and Uses, Descriptive Research Designs, Concept, Types and Uses, Experimental Design: Concept of Independent & Dependent Variables.	**20**	**6**
5	**DATA MODELING AND SIMULATIONS:** Mathematical Modeling, Experimental Skills, Simulation Skills, Data Analysis and Interpretation.	**20**	**6**
6	**INTRODUCTION TO IPR** IPR importance, Trademark, copyright, patent and its types, Trade secret, IPR and Technology Transfer	**20**	**6**
	Total	**100**	**32**

Reference Books

1.	**John W. Creswell, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches”, SAGE Publications Ltd**
2.	**C.R. Kothari,”Research Methodology: Methods and Techniques”, New Age International Publishers.**
3.	**David SiIverman,”QuaIitative Research”, SAGE Publications Ltd**

Course Outcome

After Learning the Course the students shall be able to:

1. Understand Mathematical Modeling – Explain the principles of mathematical modeling and its applications in research and problem-solving.
2. Develop Experimental and Simulation Skills – Gain proficiency in designing and executing experiments, as well as using simulation techniques for data-driven research.
3. Perform Data Analysis and Interpretation – Apply statistical and computational tools to analyze research data and derive meaningful insights.
4. Utilize Simulation Techniques – Implement various simulation methods to model real-world scenarios and validate research hypotheses.
5. Understand Intellectual Property Rights (IPR) – Explain the importance of IPR, including trademarks, copyrights, patents (and their types), trade secrets, and technology transfer in research and innovation.

Course: MTech

Prerequisite: Basic knowledge of Environmental Science or Geography

Semester: 1

Rationale : This course enables students to understand, assess, and manage various types of disasters, their impacts, and mitigation strategies, thereby fostering resilience and sustainable development.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
2	-	-	-	0	50	50	-	-	-	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Disaster:**Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity Disaster and Development and disaster management Types (Geological Disasters, Hydro-Meteorological Disasters, Biological Disasters, Technological Disasters and Man-made Disasters) , Global Disaster Trends, Causes, Consequences and Control of Disasters.	**20**	**12**
2	**Disaster Management Cycle and Framework:**Disaster Management Cycle -Paradigm Shift in Disaster Management, Pre-Disaster -Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster -Evacuation -Disaster Communication -Search and Rescue -Emergency Operation Centre -Incident Command System -Relief and Rehabilitation -Postdisaster -Damage and Needs Assessment, Restoration of Critical Infrastructure -Early Recovery -Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action.	**30**	**14**
3	**Disaster Management in India:**Disaster Profile, Lessons Learnt from Major Disasters, Disaster Management Act 2005 -Institutional and Financial Mechanism National Policy on Disaster Management, Roles and responsibilities of Government (States, Centre) and other stakeholders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA).	**30**	**12**
4	**Technology for Disaster Management & Mitigation:**Geo-informatics in Disaster Management (GIS, GPS), Disaster Communication System (Early Warning system), Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions, Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.	**20**	**10**
	Total	**100**	**48**

Reference Books

1.	**'Introduction to Disaster Management'** By Modh Satish | Macmilan Publishers India
2.	**An overview on natural & man-made disasters and their reduction** By R K Bhandani
3.	**Disaster Administration And Management Text And Case Studies** By Goel S. L., | Deep &Deep Publication Pvt. Ltd., New Delhi.
4.	**Disaster Management** By B.Narayan | Rawat Publication

Course Outcome

After Learning the Course the students shall be able to:

1. Differentiate types of disasters, identify their causes, and evaluate their impact on the environment and society.
2. Analyse disaster damage and apply effective management strategies.
3. Assess vulnerability and recommend appropriate risk mitigation measures.
4. Develop a hazard and vulnerability profile using relevant tools and techniques.
5. Classify structural and non-structural disaster mitigation strategies.

Course: MTech

Prerequisite: Mathematical and Statistical Knowledge, Python or R

Semester: 2

Rationale : The objective of this course is to equip students with the skills to analyze, interpret, and draw insights from data using statistical and computational techniques. It also aims to develop proficiency in visualizing data effectively to support decision-making and communication.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Data Analytics and Decision Systems**Types of analytics, AI in decision-making, Data-driven systems, Conversational AI, Chatbots	15	5
2	**Fundamentals of Data Visualization**Principles of visual design, Visual perception, Types of charts (bar, line, scatter, heatmaps), Choosing visual forms, Data storytelling techniques	18	8
3	**Tools for Data Visualization**Tableau, Power BI, Matplotlib, Seaborn, Plotly, Data preparation and integration, Creating static and dynamic visualizations	18	8
4	**Predictive and Prescriptive Analytics**Data mining: clustering, classification, Predictive modeling: regression, decision trees, Optimization and simulation, Spreadsheet modeling	22	8
5	**Recent Trends in Data Visualization**Real-time and interactive dashboards, Geospatial visualizations, Streaming data, Mobile-first design, Augmented analytics, AI-generated visuals, Ethical design	12	8
6	**Recent Trends in Data Analytics**Text analytics, Web and social media analysis, Cloud and edge analytics, Federated learning, Explainable AI, Data ethics and privacy	15	8
	Total	**100**	**45**

Reference Books

1.	**"Data Analytics " by Anil Maheshwari**
2.	**Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I python** By William McKinney | Shroff/O'Reilly | 2nd, Pub. Year 2017
3.	**Statistical and Econometric Methods for Transportation Data Analysis** By S. P. Washington, M. G. Karlaftis, F. L. Mannering, | CRC Press, 2010. | 2

Course Outcome

After Learning the Course the students shall be able to:

1. Understand and explain the data analytics process.
2. Create effective data visualizations using various tools.
3. Build predictive models for data-driven insights.
4. Visualize real-time and spatial data interactively.
5. Apply analytics on text and social media data ethically.

Course: MTech

Prerequisite: Mathematical and Statistical Knowledge, Python or R

Semester: 2

Rationale : The objective of this course is to equip students with the skills to analyze, interpret, and draw insights from data using statistical and computational techniques. It also aims to develop proficiency in visualizing data effectively to support decision-making and communication.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

1. Apply data extraction, cleaning, and transformation techniques using Power BI and Tableau for business analytics.
2. Create interactive dashboards and visualizations to analyze and present data-driven insights effectively.
3. Develop KPI-based performance tracking systems for monitoring business operations and decision-making.
4. Implement advanced data analytics and forecasting techniques using DAX, LOD expressions, and AI-powered insights.
5. Publish and share reports on cloud platforms like Power BI Service and Tableau Online for collaborative business intelligence.

List of Practical	
1.	**A- To Connect and Load Data from Multiple Sources in Power BI and Tableau** Import data from Excel, SQL databases, CSV, and online sources into Power BI and Tableau.
2.	**A. To Perform Data Cleaning and Transformation using Power Query and Tableau Prep** Handle missing values, remove duplicates, and reshape data using built-in tools.
3.	**To Create Basic Visualizations: Bar Charts, Line Graphs, and Pie Charts** Develop fundamental visual representations for **business data insights**.
4.	**To Design an Interactive Dashboard for Business Intelligence** Build **interactive dashboards** in Power BI and Tableau with **filters, slicers, and drill-down features**.
5.	**To Design an Interactive Dashboard for Business Intelligence** Build **interactive dashboards** in Power BI and Tableau with **filters, slicers, and drill-down features**.
6.	**To Perform Advanced Data Analytics using DAX and Tableau Calculations** Use **DAX functions (Power BI)** and **LOD expressions (Tableau)** for calculated fields and complex aggregations.
7.	**To Develop a Time-Series Forecasting Dashboard** Implement **trend analysis and predictive forecasting** for sales or stock data.
8.	**To Create Geo-Spatial Visualizations using Maps** Use **map visualizations** in Power BI and Tableau to analyze geographical data (e.g., regional sales analysis).
9.	**To Integrate AI and Machine Learning Features in Power BI and Tableau** Leverage **AI insights, sentiment analysis, and predictive modeling** using Power BI AI visuals and Tableau ML integration.
10.	**To Publish and Share Reports using Power BI Service and Tableau Online** Deploy dashboards to the **Power BI Service or Tableau Public**, set up data refresh schedules, and manage access controls.

Course: MTech

Prerequisite: Fundamentals of Knowledge of AI & ML

Semester: 2

Rationale : This course aims to provide a foundational understanding of deep learning concepts, architectures, and algorithms. It focuses on building and training neural networks for applications in computer vision, natural language processing, and other AI domains.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Fundamentals of Linear, Algebra, Probability and Machine Learning:**Revision of Linear Algebra and Probability, Basics of Machine Learning, Overview of deep learning concepts.	15	2
2	**Neural Networks and Optimization Techniques:**Introduction to Perceptron, Neural Networks, Deep Feedforward Networks, Backpropagation, Gradient Descent, Sampling Techniques, Regularization, and Dropout.	20	3
3	**Implementation of Deep Learning Frameworks:**Case studies and hands-on implementation of deep learning models using TensorFlow and PyTorch (spread across the semester).	10	2
4	**Convolutional Neural Networks (CNNs) for Computer Vision:** Concepts of Convolutional Networks, Feature Extraction, Applications in Image Recognition and Object Detection.	15	2
5	**Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTMs):**Fundamentals of Recurrent Neural Networks (RNNs), LSTMs, Applications in Natural Language Processing (NLP) such as text generation, machine translation, and speech recognition.	15	2
6	**Autoencoders and Representation Learning:** Autoencoders, Variational Autoencoders (VAEs), Applications in Dimensionality Reduction and Representation Learning.	10	1
7	**Generative Adversarial Networks (GANs) :**Fundamentals of **GANs**, Generator vs. Discriminator, Applications in **Image Generation and Data Augmentation**.	7	1
8	**Bayesian Deep Learning :** Introduction to Bayesian Deep Learning, Uncertainty Estimation in Deep Learning Models, Probabilistic Neural Networks.	8	1
	Total	**100**	**14**

Reference Books

1.	**Deep Learning,** By by Goodfellow, Bengio, and Courville
2.	**Deep Learning with Python** By François Chollet
3.	**Christopher M. Bishop, ―Pattern Recognition and Machine Learning‖, Springer 2011 Edition.**
4.	**Deep Learning and Neural Networks** By Jeff Heaton | Heaton Research Inc, 2015

5.	**"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" Author: Aurélien Géron | Publisher: O'Reilly Media**

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Understand the fundamentals of deep learning by applying concepts from linear algebra, probability, and machine learning.
2. Implement and optimize deep neural networks using techniques like backpropagation, gradient descent, regularization, and dropout.
3. Apply deep learning frameworks such as TensorFlow and PyTorch to build and analyze real-world AI applications.
4. Develop advanced deep learning models including CNNs for computer vision, RNNs/LSTMs for NLP, and GANs for generative modeling.
5. Explore Bayesian deep learning and representation learning to enhance model interpretability, uncertainty estimation, and feature extraction.

Course: MTech

Prerequisite: Fundamentals of Knowledge of AI & ML

Semester: 2

Rationale : This course aims to provide a foundational understanding of deep learning concepts, architectures, and algorithms. It focuses on building and training neural networks for applications in computer vision, natural language processing, and other AI domains.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Understand the fundamentals of deep learning by applying concepts from linear algebra, probability, and machine learning.
2. Implement and optimize deep neural networks using techniques like backpropagation, gradient descent, regularization, and dropout.
3. Apply deep learning frameworks such as TensorFlow and PyTorch to build and analyze real-world AI applications.
4. Develop advanced deep learning models including CNNs for computer vision, RNNs/LSTMs for NLP, and GANs for generative modeling.
5. Explore Bayesian deep learning and representation learning to enhance model interpretability, uncertainty estimation, and feature extraction.

List of Practical

1.	**To Implement Perceptron and Multi-Layer Neural Networks**
2.	**To Apply Optimization Techniques in Deep Learning**
3.	**To Build Deep Neural Networks using TensorFlow and PyTorch**
4.	**To Implement Convolutional Neural Networks (CNNs) for Image Classification**
5.	**To Develop Recurrent Neural Networks (RNNs) and LSTMs for Text Processing**
6.	**To Implement Autoencoders and Variational Autoencoders (VAEs)**
7.	**To Build a Generative Adversarial Network (GAN) for Image Generation**
8.	**To Perform Transfer Learning using Pre-Trained Models**
9.	**To Explore Bayesian Deep Learning for Uncertainty Estimation**
10.	**To Deploy a Deep Learning Model using Flask or FastAPI**

Course: MTech

Prerequisite: Parallel Processing

Semester: 2

Rationale : This course aims to introduce the principles of high performance computing (HPC) and parallel programming models. It focuses on developing scalable algorithms and implementing them on multicore, GPU, and distributed computing systems.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to High-Performance Computing (HPC):**Definition, history, Moore's law, scientific computing challenges, processor topology, heat conduction problem, storage, power, and thermal management, IEEE standards, Unix shell, virtual machines.	10	2
2	**Programming Languages, Version Control, and Build Systems:**Compiled programming languages, precision, compiler optimization, Git version control (commands, GitHub), build systems (makefiles, dependency checking).	15	4
3	**Python for Scientific Computing and Data Handling:** Python syntax, conditionals, loops, functions, NumPy, SciPy, Jupyter Notebook, debugging, just-in-time compilers (PyPy, Numba, LLVM), data visualization (matplotlib, ParaView), ASCII and binary formats (HDF, NetCDF).	15	4
4	**Parallel Computing Concepts and Architectures:**Introduction to parallelization, memory hierarchy, cache optimization, parallelizing algorithms (strip mining, loop reordering), shared and distributed memory, scaling laws (Amdahl's law), SPMD and SIMD models, fine and coarse-grain parallelism.	15	4
5	**Parallel Programming with OpenMP and MPI:**OpenMP (fork-join model, synchronization, race conditions, stack vs. heap memory, reductions), MPI (message passing, domain decomposition, master-worker paradigm, MPI send/receive functions), comparison of OpenMP and MPI.	15	4
6	**General-Purpose Computing on GPUs (GPGPU):** Introduction to GPU architecture, differences between CPU and GPU computing, massively parallel processing, memory hierarchy in GPUs, SIMD execution model, GPU programming challenges, applications of GPGPU in scientific computing.	15	4
7	**CUDA Programming for High-Performance Computing :**Introduction to CUDA, CUDA programming model, thread hierarchy, memory management in CUDA, kernel execution, optimizing CUDA performance, real-world applications of CUDA for HPC.	15	4
	Total	**100**	**26**

Reference Books

1.	**Programming Massively Parallel Processors: A Hands-on Approach;** By David Kirk, Wen-mei Hwu; Morgan Kaufman;, Pub. Year 2010
2.	**1. Parallel Programming in C with MPI and OpenMP** By M.J. Quinn | McGraw-Hill Science/Engineering/Math.
3.	**CUDA by Example – An Introduction to General Purpose GPU Programming** By Edward Kandrot and Jason Sanders, Addison-Wesley Professional, 2010.

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: 1. Analyze and apply parallel computing concepts to optimize computational performance in scientific and engineering applications. 2. Develop high-performance applications using OpenMP, MPI, and CUDA programming models for shared and distributed memory systems. 3. Implement GPGPU programming techniques to accelerate complex computations using GPU architectures. 4. Utilize HPC resources and scientific computing methods to solve large-scale computational problems in real-world scenarios.

Course: MTech

Prerequisite: Parallel Processing

Semester: 2

Rationale : This course aims to introduce the principles of high performance computing (HPC) and parallel programming models. It focuses on developing scalable algorithms and implementing them on multicore, GPU, and distributed computing systems.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:

1. Analyze and apply parallel computing concepts to optimize computational performance in scientific and engineering applications.
2. Develop high-performance applications using OpenMP, MPI, and CUDA programming models for shared and distributed memory systems.
3. Implement GPGPU programming techniques to accelerate complex computations using GPU architectures.
4. Utilize HPC resources and scientific computing methods to solve large-scale computational problems in real-world scenarios.

List of Practical

1.	To Implement Parallel Programming using OpenMP for Multi-threading
2.	To Develop MPI Programs for Message Passing Communication
3.	To Perform Parallel Matrix Multiplication using OpenMP and MPI
4.	To Implement Scientific Computing Algorithms using Python (NumPy, SciPy)
5.	To Develop a CUDA Program for the Addition of Two Numbers
6.	To Optimize CUDA Programs using CUDA Profiler (Nsight)
7.	To Implement a CUDA Program for Array Addition
8.	To Develop a CUDA Program for Parallel Image Processing
9.	To Implement a CUDA Program for Matrix Transposition
10.	Case Study on Real-World HPC Applications using OpenMP, MPI, and CUDA

Course: MTech **Semester:** 2

Prerequisite: Linear Algebra and Probability Theory, Data Structures and Algorithms, Python Programming, Introduction to Classical Computing and Logic Gates

Rationale : This course introduces students to the fundamental principles and applications of quantum computing. It covers key concepts such as superposition, entanglement, and quantum gates, along with algorithms like Grover's and Shor's. Students will gain hands-on experience with quantum programming using tools like IBM Qiskit and Google Cirq, applying quantum techniques to data science problems. By the end, they will be equipped to develop and implement quantum solutions while understanding the field's potential and limitations.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Essential Linear Algebra:**Some Basic Algebra, Matrix Math, Vectors and Vector Spaces, Set Theory. Complex Numbers: Definition of Complex Numbers, Algebra of Complex Numbers, Complex Numbers Graphically, Vector Representations of Complex Numbers, Pauli Matrice, Transcendental Numbers	20	8
2	**Basic Physics for Quantum Computing:**The Journey to Quantum, Quantum Physics Essentials, Basic Atomic Structure, Hilbert Spaces, Uncertainty, Quantum States, Entanglement Basic Quantum Theory: Further with Quantum Mechanics, Quantum Decoherence, Quantum Electrodynamics, Quantum Chromodynamics, Feynman Diagram Quantum Entanglement and QKD, Quantum Entanglement, Interpretation, QKE	25	12
3	**Quantum Architecture:**Further with Qubits, Quantum Gates, More with Gates, Quantum Circuits, The D-Wave Quantum Architecture. Quantum Hardware: Qubits, How Many Qubits Are Needed? Addressing Decoherence, Topological Quantum Computing, Quantum Essentials.	20	10
4	**Quantum Algorithms:**What Is an Algorithm? Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm	20	6
5	**Current Asymmetric Algorithms:**RSA, Diffie-Hellman, Elliptic Curve The Impact of Quantum Computing on Cryptography: Asymmetric Cryptography, Specific Algorithms, Specific Applications	15	6
	Total	**100**	**42**

Course Outcome

After Learning the Course the students shall be able to:

After completing the course, the students shall be able to:
1. Understand basics of quantum computing
2. Understand physical implementation of Qubit
3. Understand Quantum algorithms and their implementation
4. Understand The Impact of Quantum Computing on Cryptography

Course: MTech **Semester:** 2

Prerequisite: Linear Algebra and Probability Theory, Data Structures and Algorithms, Python Programming, Introduction to Classical Computing and Logic Gates

Rationale : This course introduces students to the fundamental principles and applications of quantum computing. It covers key concepts such as superposition, entanglement, and quantum gates, along with algorithms like Grover's and Shor's. Students will gain hands-on experience with quantum programming using tools like IBM Qiskit and Google Cirq, applying quantum techniques to data science problems. By the end, they will be equipped to develop and implement quantum solutions while understanding the field's potential and limitations.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	Internal Marks			External Marks		
					T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After completing the course, the students shall be able to:
1. Understand basics of quantum computing
2. Understand physical implementation of Qubit
3. Understand Quantum algorithms and their implementation
4. Understand The Impact of Quantum Computing on Cryptography

List of Practical	
1.	**Matrix Operations in Quantum Computing** • Perform matrix addition, multiplication, and eigenvalue calculations. • Implement Pauli matrices and their operations.
2.	**Complex Numbers & Vector Spaces** • Represent complex numbers graphically and perform arithmetic operations. • Implement vector spaces and transformations in Python.
3.	**Simulating Quantum Superposition & Entanglement** • Create and visualize quantum **superposition** using Hadamard gates. • Implement quantum **entanglement** with CNOT gates in Qiskit.
4.	**Quantum Key Distribution (BB84 Protocol)** • Simulate and analyze the **BB84 quantum key distribution protocol**.
5.	**Building Quantum Circuits** • Design and execute quantum circuits using Hadamard, CNOT, and Toffoli gates in Qiskit.
6.	**Quantum Annealing with D-Wave** • Simulate an optimization problem using **D-Wave Leap** for quantum annealing.
7.	**Implementation of Deutsch's & Grover's Algorithms** • Implement **Deutsch's algorithm** for function determination. • Implement **Grover's search algorithm** for unstructured database search.
8.	**Shor's Algorithm for Integer Factorization** • Simulate **Shor's algorithm** for factoring large integers and breaking RSA encryption.
9.	**Quantum Cryptography & Post-Quantum Security** • Compare **classical RSA** encryption with **quantum-resistant cryptographic algorithms**.
10.	**Quantum Teleportation Experiment** • Implement **quantum teleportation** using Qiskit and analyze quantum communication protocols.

Course: MTech **Semester:** 2

Prerequisite: Data Science and Programming, Mathematics and Statistics, Algorithms and Data Structure

Rationale : This course aims to expose students to the field of Data Science within the context of its growing importance in biology and bioinformatics. It focuses on equipping students with the skills to apply various data science methodologies and techniques to analyze biological data. Through the course, students will gain proficiency in using bioinformatics tools for data analytics and learn to implement deep learning approaches for solving complex biological problems. Additionally, the course emphasizes the application of data science models in areas such as genomic analysis, proteomics, and drug discovery, preparing students to tackle real-world challenges in computational biology.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Scalable Algorithms:Scalable Algorithms:** Challenges of Massive Data, The Scalability of Algorithms, Complexity Class S, Scalable Reduction and Algorithmic Primitives **Networks and Data:** Weighted Graphs and Affinity Networks, Possible Sources of Affinities, Beyond Graph Models for Social/Information Networks, Basic Problems in Data and Network Analysis, Sparse Networks and Sparse Matrices. **Significant Nodes: Sampling - Making Data Smaller:** Personalized PageRank Matrix, Multi-Precision Annealing for Significant Page Rank, Local Approximation of Personalized PageRank, Multi-Precision Sampling, Significant- PageRank Identification.	20	8
2	**Partitioning: Geometric Techniques for Data Analysis:** Centerpoints and Regression Depth, Scalable Algorithms for Center points, Geometric Separators , Dimension Reduction: Random vs Spectral, Scalable Geometric Divide-and-Conquer, Graph Partitioning: Vertex and Edge Separators, Multiway Partition of Network and Geometric Data, Spectral Graph Partitioning: The Geometry of a Graph.	20	8
3	**Overview of data mining:** Map-reduce, Hash Functions, shingling of documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, Link-analysis Page Rank,Link Spam, Hubsand authorities. Frequent Item sets: Market based model, A-Priori Algorithm, Handling larger data sets in memory, Limited-pass algorithms.	20	10
4	**Introduction to the Basics of Molecular Biology:Introduction to the Basics of Molecular Biology**: Basic cell architecture, the structure, content and scale of deoxyribonucleic acid (DNA), History of the human genome, Genes and proteins, Current knowledge and the 'central dogma', Why proteins are important, Gene and cell regulation, when cell regulation goes wrong, what is bioinformatics? **Introduction to Problems and Challenges in Bioinformatics:** Introduction, Genome, Transcriptome, Proteome, Interference Technology, viruses, and the immune system.	20	8
5	**Future Techniques: Genetic Programming:**Method, Application guidelines, Bioinformatics applications, Background. **Cellular Automata:** Method, Application guidelines, Bioinformatics applications, Background. **Hybrid Methods:** Method, Neural-genetic algorithm for analysing gene expression data, Genetic algorithm, and k nearest neighbour hybrid for biochemistry solvation, Genetic programming neural networks for determining gene–gene interactions in epidemiology, Application guidelines, Conclusions.	20	8
	Total	**100**	**42**

Reference Books	
1.	**Introduction to Bioinformatics – Arthur M. Lesk: A concise overview of bioinformatics tools and methods with biological applications.**
2.	**Data Science from Scratch: First Principles with Python** By Joel Grus | O'Reilly Media
3.	**Bioinformatics** By DAVID W MOUNT

Course Outcome
After Learning the Course the students shall be able to:
After completing the course, the students shall be able to: 1. Apply data science techniques to analyze biological data. 2. Use bioinformatics tools for genomic and proteomic analysis. 3. Implement deep learning models for bioinformatics applications. 4. Handle and process large-scale biological datasets. 5. Build and apply predictive models for biological outcomes. 6. Visualize and interpret bioinformatics data effectively.

Course: MTech **Semester:** 2

Prerequisite: Data Science and Programming, Mathematics and Statistics, Algorithms and Data Structure

Rationale : This course aims to expose students to the field of Data Science within the context of its growing importance in biology and bioinformatics. It focuses on equipping students with the skills to apply various data science methodologies and techniques to analyze biological data. Through the course, students will gain proficiency in using bioinformatics tools for data analytics and learn to implement deep learning approaches for solving complex biological problems. Additionally, the course emphasizes the application of data science models in areas such as genomic analysis, proteomics, and drug discovery, preparing students to tackle real-world challenges in computational biology.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After completing the course, the students shall be able to:
1. Apply data science techniques to analyze biological data.
2. Use bioinformatics tools for genomic and proteomic analysis.
3. Implement deep learning models for bioinformatics applications.
4. Handle and process large-scale biological datasets.
5. Build and apply predictive models for biological outcomes.
6. Visualize and interpret bioinformatics data effectively.

List of Practical

1. Data Handling & Visualization in Bioinformatics

- Load and preprocess **biological datasets** using Pandas & NumPy.
- Visualize **genomic & healthcare data** using Matplotlib & Seaborn.

2. Data Transformation for Bioinformatics

- Perform **normalization, scaling, and feature extraction** on biological data.
- Handle **missing data in bioinformatics datasets**.

3. Genomics Data Processing

- Analyze **DNA sequences** and convert genetic data into meaningful formats.
- Perform **multiple sequence alignment (MSA)** using Biopython.

4.	**Phylogenetic Tree Construction** • Build **phylogenetic trees** from genetic sequences using **ClustalW** or **MEGA**.

	• Visualize evolutionary relationships using **ETE Toolkit**.
5.	**Protein Structure Prediction** • Analyze **protein sequences** and predict secondary structures. • Use **AlphaFold or PyMOL** for protein structure visualization.
6.	**Structural Bioinformatics & Drug Discovery** • Perform **docking simulations** for structure-based drug design. • Analyze **protein-ligand interactions** using AutoDock or PyRx.
7.	**AI & Machine Learning for Bioinformatics** • Apply **classification models** (SVM, Random Forest) for disease prediction. • Use **clustering techniques** (K-means, Hierarchical) for gene expression data.
8.	**Graph Algorithms for Biological Networks** • Implement **graph-based analytics** for protein interaction networks. • Use **NetworkX** to visualize biological relationships.
9.	**Deep Learning for Genomics & Proteomics** • Train a **CNN/RNN model** for gene sequence classification. • Implement **GANs for synthetic biological data generation**.
10.	**Whole-Cell Modeling & Simulation** • Simulate **biological pathways and metabolic networks**. • Use **COBRApy** for metabolic model analysis.

Course: MTech

Prerequisite: Programming and Data Structures, Mathematics and Statistics

Semester: 2

Rationale : This course aims to provide a foundational understanding of Natural Language Processing (NLP) techniques for analyzing and generating human language. It focuses on text preprocessing, syntax and semantics, machine learning models, and real-world NLP applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction:**Definition and origins of NLP, language and knowledge representation, challenges in NLP, grammar and syntax, NLP applications, processing Indian languages, statistical language models (N-gram, unigram, bigram), Paninian framework, Karaka theory.	18	7
2	**Word-Level and Syntactic Analysis :** Regular expressions, finite-state automata, morphological parsing, spelling error detection and correction, words and word classes, part-of-speech tagging, context-free grammar, parsing techniques (top-down, bottom-up, CYK).	18	8
3	**Text Classification and Sentiment Analysis :**Naive Bayes classifiers, training and optimization, sentiment analysis, text classification tasks, Naive Bayes as a language model.	15	6
4	**Information Retrieval and Lexical Resources**Information retrieval system design, classical and non-classical retrieval models, alternative retrieval models (Cluster, Fuzzy, LSTM), WordNet, FrameNet, stemming, POS tagging, research corpora.	15	6
5	**Machine Translation and Ethical Considerations:**Language divergences and typology, machine translation using encoder-decoder models, low-resource translation challenges, evaluation methods, bias and ethical concerns in NLP.	18	8
6	**Recent Trends and Research in NLP**Transformer architectures (BERT, GPT), multilingual NLP, zero-shot and few-shot learning, NLP for low-resource languages, ethical AI in NLP, future research directions.	18	7
	Total	**102**	**42**

Reference Books

1.	**Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition** By Daniel Jurafsky and James H Martin | Pearson Education, Pub. Year 2002
2.	**An Introduction to Information Retrieval** By Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze | Cambridge University Press
3.	**“Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit” by Steven Bird, Ewan Klein, and Edward Lope**
4.	**“Handbook of Natural Language Processing” by Nitin Indurkhya and Fred J. Damerau**

Course Outcome

After Learning the Course the students shall be able to:
After Learning the Course the students shall be able to: Apply fundamental NLP techniques such as language modeling, text processing, and syntactic analysis. Develop text classification and sentiment analysis models using machine learning techniques like Naive Bayes. Implement information retrieval and machine translation systems for various linguistic applications. Analyze recent advancements in NLP including transformers, multilingual models, and ethical consideration.

Course: MTech

Prerequisite: Programming and Data Structures, Mathematics and Statistics

Semester: 2

Rationale : This course aims to provide a foundational understanding of Natural Language Processing (NLP) techniques for analyzing and generating human language. It focuses on text preprocessing, syntax and semantics, machine learning models, and real-world NLP applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the Course the students shall be able to:
1. Apply fundamental NLP techniques such as language modeling, text processing, and syntactic analysis.
2. Develop text classification and sentiment analysis models using machine learning techniques like Naive Bayes.
3. Implement information retrieval and machine translation systems for various linguistic applications.
4. Analyze recent advancements in NLP including transformers, multilingual models, and ethical consideration.

List of Practical

1.	**Basic Text Handling in Python – Read, write, and manipulate text data using Python.**
2.	**Basic Regular Expressions for NLP – Use regex for text pattern matching and extraction.**
3.	**Text Preprocessing in NLP using Python – Implement tokenization, filtration, script validation, stop word removal, and stemming.**
4.	**N-Gram Language Modeling – Demonstrate unigrams, bigrams, and trigrams and analyze their impact on sentence probability.**
5.	**Minimum Edit Distance Algorithm – Implement string comparison to calculate edit operations like insertions, deletions, and substitutions.**
6.	**Parsing with Context-Free Grammar – Develop a top-down and bottom-up parser using CFG.**
7.	**Text Classification using Naïve Bayes – Classify a new document based on movie reviews using a Naïve Bayes classifier with add-1 smoothing.**
8.	**Information Retrieval in NLP – Work with Corpus datasets (Brown, Reuters, Inaugural, UDHR), create custom corpora, and analyze tagged corpora, frequency distributions, and rule-based taggers**
9.	**Synonyms and Antonyms using WordNet – Extract synonyms and antonyms of the word "active" using WordNet.**
10.	**Case Study on NLP Applications – Analyze real-world applications of NLP, such as chatbots, sentiment analysis, machine translation, or speech recognition.**

Course: MTech

Prerequisite: Basics of Cryptography, Computer Networks

Semester: 2

Rationale : To understand the fundamentals and real-world applications of Blockchain technology. To explore Blockchain tools, frameworks, and develop practical programming skills.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction to Blockchain**History and Evolution of Blockchain, Basics of Distributed Ledger Technology (DLT), Key Characteristics: Decentralization, Transparency, Security, Blockchain vs Traditional Databases	15	6
2	**Cryptographic Foundations & Consensus Mechanisms**Hash Functions, Public-Key Cryptography, Digital Signatures, Merkle Trees & Block Structure, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated PoS (DPoS), Proof of Authority (PoA), Byzantine Fault Tolerance (BFT)	15	6
3	**Blockchain Architecture & Smart Contracts**Blockchain Components: Nodes, Miners, Validators, Smart Contracts: Concept, Working, Use Cases, Ethereum & Solidity Programming Basics, Token Standards: ERC-20, ERC-721 (NFTs)	20	9
4	**Blockchain Tools & Platforms**Ethereum, Hyperledger Fabric, Binance Smart Chain, Smart Contract Development with Remix IDE & Solidity, Web3.js and Decentralized Application (DApp) Development	15	7
5	**Blockchain Applications & Use Cases**Cryptocurrencies (Bitcoin, Ethereum, Stablecoins), Decentralized Finance (DeFi) and Smart Contract Auditing, Supply Chain Management & Provenance Tracking, Blockchain in Healthcare, Real Estate, and Voting Systems	15	8
6	**Challenges, Security & Future Trends**Scalability & Energy Consumption Issues, Layer 2 Scaling Solutions (Lightning Network, Rollups), Security Threats: 51% Attack, Sybil Attack, Smart Contract Vulnerabilities, Central Bank Digital Currencies (CBDCs) & Future of Blockchain	20	6
	Total	**100**	**42**

Reference Books

1.	**Antonopoulos A.M., Mastering Bitcoin. 2nd ed. O'Reilly Media, 2017**
2.	**Narayanan, Arvind, et al. Bitcoin and cryptocurrency technologies: a comprehensive introduction, 2016, 1st Edition Princeton University Press, New Jersey.**
3.	**Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners** By Chris Dannen

Course Outcome
After Learning the Course the students shall be able to:
After Learning the course, the students shall be able to: 1.Understand the Cryptographic basics and Cryptocurrency 2. Understand the categories of various types of blockchain. 3. Choose a blockchain implementation based on real time scenario. 4. Identify and understand the use case of distributed ledger technology. 5. Evaluate alternative Blockchains and their applicability. 6. Examine the techniques for anonymity preservation.

Course: MTech

Prerequisite: Basics of Cryptography, Computer Networks

Semester: 2

Rationale : To understand the fundamentals and real-world applications of Blockchain technology. To explore Blockchain tools, frameworks, and develop practical programming skills.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the course, the students shall be able to:
1. Understand the Cryptographic basics and Cryptocurrency
2. Understand the categories of various types of blockchain.
3. Choose a blockchain implementation based on real time scenario.
4. Identify and understand the use case of distributed ledger technology.
5. Evaluate alternative Blockchains and their applicability.
6. Examine the techniques for anonymity preservation.

List of Practical

1. Blockchain Programming in Python:

- Develop a client class that generates private and public keys using Python's built-in RSA algorithm and test it.
- Implement a transaction class for sending and receiving money, and test its functionality.
- Create multiple transactions and display them.
- Design a blockchain with a genesis block and execute it.
- Implement a mining function and test its operations.
- Add blocks to the miner and dump the blockchain.

2. Ethereum Setup and Application Development:

- Install and configure Go Ethereum (Geth) and the Mist browser.
- Develop and test a sample Ethereum-based application.

3.	**Solidity Basics Implementation:** • Implement and demonstrate the use of variables, operators, loops, decision-making statements, strings, arrays, enums, structs, mappings, type conversions, ether units, and special variables in Solidity.

	• Develop functions, function modifiers, view functions, pure functions, fallback functions, function overloading, mathematical functions, and cryptographic functions in Solidity.
4.	**Advanced Solidity Programming:** • Implement the withdrawal pattern and restricted access mechanisms. • Demonstrate the use of contracts, inheritance, constructors, abstract contracts, and interfaces. • Work with libraries, inline assembly, events, and error handling in Solidity.
5.	**Hyperledger Fabric Setup and Application Deployment:** • Install Hyperledger Fabric and Composer. • Deploy and execute a blockchain application using Hyperledger.
6.	**Ethereum Mining Demonstration:** • Write a program to mine Ether and analyze the mining process.
7.	**Blockchain Node Execution:** • Set up and demonstrate the running of a blockchain node.
8.	**Bitcoin Core API Demonstration:** • Implement and demonstrate the use of the Bitcoin Core API.
9.	**Custom Blockchain Development:** • Create and showcase a custom blockchain and demonstrate its usage.
10.	**Building Decentralized Applications (DApps):** • Develop DApps using Angular and integrate them with a blockchain backend.

Course: MTech **Semester:** 2

Prerequisite: Basic programming knowledge, fundamentals of data science, and networking concepts.

Rationale : This course introduces students to the core concepts, principles, and practical applications of cloud computing in the field of data science. It covers cloud service models, virtualization, containerization, and big data frameworks. Students will learn how to deploy, manage, and optimize data science workflows on popular cloud platforms. The course also explores stream processing engines, messaging services, and cloud-based machine learning, providing a comprehensive understanding of how cloud technology supports large-scale data science applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
3	0	0	-	3	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Concepts and Principles of Cloud Computing:**Introduction to Cloud Computing, Cloud characteristics and benefits, Key cloud service providers (AWS, Azure, GCP), Cloud computing architecture: Frontend and backend components, Service orchestration, Cloud deployment models: Public, Private, Hybrid, and Community Clouds	10	6
2	**Cloud Computing Service Models:Infrastructure as a Service (IaaS)**: Virtual Machines (VMs), Storage and network management **Platform as a Service (PaaS):** Serverless computing, Cloud functions and APIs **Software as a Service (SaaS):** Web-based applications, Cloud-based collaboration tools	15	6
3	**Virtualization Technology:**Introduction to virtualization, Hypervisors: Type 1 and Type 2, Cloud virtualization platforms, Storage and network virtualization, Benefits of virtualization in data science	15	6
4	**Container Orchestration Framework:**Introduction to containers, Docker architecture and Docker Compose. **Kubernetes fundamentals:** Pods, services, and deployments, Load balancing and scaling. **Cloud-native container services:** AWS EKS (Elastic Kubernetes Service), Google Kubernetes Engine (GKE), Azure Kubernetes Service (AKS)	15	6
5	**Big Data Frameworks on Cloud:**Introduction to big data processing, Hadoop ecosystem: HDFS, MapReduce, YARN. Apache Spark: Resilient Distributed Dataset (RDD), DataFrames and SQL. Running big data pipelines on cloud platforms (AWS EMR, Databricks)	15	6
6	**Messaging and Data Services:**Introduction to messaging systems, Apache Kafka: Producers and consumers, Kafka topics and partitions. RabbitMQ: Message queues, Message routing. Cloud-based messaging services: AWS SQS and SNS, Google Pub/Sub, Azure Service Bus	15	6
7	**Stream Processing Engines:**Introduction to stream processing, Apache Flink: Stream processing models, Windowing and aggregation, AWS Kinesis: Real-time data streams, Integrating with Lambda functions. Apache Storm: Distributed real-time computation, Storm topologies.	15	6
	Total	**100**	**42**

Reference Books

1.	**Cloud Computing - A Practical Approach By Toby Velte, Anthony Velte, Robert Elsenpeter, Tata Mcgraw Hill**
2.	**Mastering Cloud Computing Foundations and Applications Programming** By Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi
3.	**Cloud Computing Theory and Practice** By Dan C Marinescu | Elsevier(MK)

Course Outcome

After Learning the Course the students shall be able to:

After Learning the course, the students shall be able to:
1. Understand the Cryptographic basics and Cryptocurrency
2. Understand the categories of various types of blockchain.
3. Choose a blockchain implementation based on a real time scenario.
4. Identify and understand the use case of distributed ledger technology.
5. Evaluate alternative Blockchains and their applicability.
6. Examine the techniques for anonymity preservation.

Course: MTech **Semester:** 2

Prerequisite: Basic programming knowledge, fundamentals of data science, and networking concepts

Rationale : This course introduces students to the core concepts, principles, and practical applications of cloud computing in the field of data science. It covers cloud service models, virtualization, containerization, and big data frameworks. Students will learn how to deploy, manage, and optimize data science workflows on popular cloud platforms. The course also explores stream processing engines, messaging services, and cloud-based machine learning, providing a comprehensive understanding of how cloud technology supports large-scale data science applications.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
0	0	2	-	1	-	-	20	-	30	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Outcome

After Learning the Course the students shall be able to:

After Learning the course, the students shall be able to:
1. Understand the Cryptographic basics and Cryptocurrency
2. Understand the categories of various types of blockchain.
3. Choose a blockchain implementation based on a real time scenario.
4. Identify and understand the use case of distributed ledger technology.
5. Evaluate alternative Blockchains and their applicability.
6. Examine the techniques for anonymity preservation .

List of Practical

1.	Creating free-tier accounts on AWS, Azure, and GCP
2.	Exploring cloud consoles and basic services
3.	Deploying a virtual machine on AWS EC2
4.	Running a simple data science model on Google Cloud AI Platform
5.	Launching and configuring VMs on AWS and GCP
6.	Managing VM snapshots and backups
7.	Building and deploying a Docker container with a Python-based data science app
8.	Deploying and scaling containers with Kubernetes
9.	Running PySpark jobs on Google Colab with GCP integration
10.	Performing distributed data processing using AWS EMR
11.	Setting up Kafka clusters on the cloud
12.	Implementing a real-time messaging system using AWS SQS
13.	Building a real-time data streaming pipeline using AWS Kinesis
14.	Analyzing and visualizing streaming data with Apache Flink

Course: MTech **Semester:** 2

Prerequisite: A basic familiarity with education systems, classroom teaching–learning processes, and introductory research concepts is required.

Rationale : This course aims to develop a critical and research-informed understanding of pedagogical practices, curriculum, teacher education, and professional development, with a special focus on evidence-based approaches and contextual challenges.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
2	-	-	-	0	50	50	-	-	-	50

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction and Methodology** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching	25	6
2	**Thematic overview** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.	13	6
3	**Evidence on the effectiveness of pedagogical practices Methodology for the in-depth stage**Quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches, Teacher's attitudes and beliefs and Pedagogic strategies	25	6
4	**Professional development**Alignment with classroom practices and follow-up support, Peer support Support from the head teacher and the community Curriculum and assessment Barriers to learning: limited resources and large class sizes	25	6
5	**Research Gaps**Research gaps and future directions, Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	12	6
	Total	**100**	**30**

Reference Books

1.	**Education for All, the Quality Imperative and the Problem of Pedagogy** By Alexander, R | CREATE, University of Cambridge, Pub. Year 2008
2.	**Teaching for Quality Learning at University** By Biggs, J. & Tang, C | Open University Press, Pub. Year 2011
3.	**Studying Teacher Education: The Report of the AERA Panel on Research and Teacher Education** By Cochran-Smith, M., & Zeichner, K. | Lawrence Erlbaum Associates, Pub. Year 2005
4.	**Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement** By Hattie, J. | Routledge, Pub. Year 2009
5.	**Education 2030: Incheon Declaration and Framework for Action** By UNESCO | UNESCO, Pub. Year 2015

6.	**National Curriculum Framework** By NCERT | NCERT, Pub. Year 2005

Course Outcome
After Learning the Course the students shall be able to:
Remember key concepts, theories of learning, and pedagogical terminology relevant to curriculum and teacher education. Understand diverse pedagogical practices used in formal and informal classroom contexts.
Apply appropriate research methodologies to evaluate the effectiveness of pedagogical practices.
Analyze evidence from educational studies to assess strengths, limitations, and research gaps in pedagogy.
Evaluate professional development models and curriculum frameworks to recommend context-sensitive improvements.

Course: MTech **Semester:** 2

Prerequisite: Inclination to learn machine Learning, basic knowledge of differential classification clustering and regression algorithms , Data Mining.

Rationale : The course will provide a strong foundation on business analytics and the basic concepts.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
4	-	-	-	4	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Business analytics**Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	15	10
2	**Trendiness and Regression Analysis**Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	15	10
3	**Organization Structures of Business analytics**Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.	20	12
4	**Forecasting Techniques**Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	20	12
5	**Decision Analysis**Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	20	12
6	**Recent Trends in**Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	10	4
	Total	**100**	**60**

Reference Books

1.	**"Fundamentals of Business Analytics" by R.N.Prasad and Seema Acharya (TextBook)**
2.	**"Business Analytics – The Science of DataDriven Decision Making" by U. Dinesh Kumar (TextBook)**
3.	**"Data Analytics " by Anil Maheshwari**
4.	**"Business Analytics for Managers: Taking Business Intelligence Beyond" by Jesper Thorlund & Gert H.N. Laursen**
5.	**“Business Analytics ”, by Sahil Raj**

Course Outcome
After Learning the Course the students shall be able to:
1. Explain business analytics and its role within an organization. 2. Acquire domain knowledge of business analytics and its critical concepts. 3. Understand business intelligence systems and applications of business analytics. 4. Implement business problems and to support managerial decision making.

Course: MTech **Semester:** 2

Prerequisite: Basic knowledge of safety in the field of electrical engineering, chemical engineering, civil engineering and fire safety.

Rationale : The main objective of this subject is to introduce practical knowledge of industrial safety and its maintenance considering different acts and standards related to safety. It also helps in understanding different types of hazards and safety precautions to avoid these hazards. The subject will also help in gaining field knowledge related to safety audit and policies.

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	Internal Marks			External Marks		Total
					T	CE	P	T	P	
4	-	-	-	4	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Introduction:** Introduction to Industrial Safety, History and Development of Safety Movements, Safety Programs, Need for Safety, Different Safety Acts, Rules, Standards, Safety Organizations and Responsibilities, Safety Policy, Requirement and Responsibility of Safety Officer and Safety Committee, Safety Audit.	12	8
2	**Health & Safety Management and Audit - Standards and Acts:** Occupational Health and Safety Audit - Code of Practice (IS 14489), Occupational Health and Safety System Elements, Occupational Health and Safety Policy, Organizational Setup, Safety Manual, Safety Culture, Hazard Identification and Job Safety Analysis, Product Safety and Safety Training, The Factory Act 1948, The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989, The Central Electricity Authority Regulations, 2011, The Static and Mobile Pressure Vessels Rules, 2016, The Gas Cylinder Rules, 2016, The Explosive Rules, 2008, The Building and other Construction Workers Act, 1996.	24	14
3	**Physical and Chemical Hazard:** Machine and General Area Guarding, Material Handling, Safety in Storage, New Equipment Inspection, Electrical Hazard: Hazards related to Electrical Energy, Safe limits of Ampere & Voltage, Safe Distance from Power Lines, Means of Cutting off Power, Overload and Short Circuit Protection, Protection against Voltage Fluctuation, Protection for Electrical Equipments in Hazardous Atmosphere, Hazardous Area Classification, Criteria for Selection, Installation, Maintenance and Use of Equipment in Hazardous Areas, Electrical Safeguarding, Earthing, Importance of Earthing, Parameters related to Earthing, Earthing Design for Safety considering IEEE Standard, Chemical Hazard: Transportation of Hazardous Materials, Safety and Handling of Storage of Hazardous Chemicals, Gas Cylinders, Labelling and Colour Coding.	24	14
4	**Fire Hazard:** Fire Phenomena, Chemistry of Fire, Stages of Fire, Factors contributing to Fire, Classification of Fires, Common causes of Industrial Fires, Building, Plant and Exits Design considering Prevention of Fire and Fire Safety, Safety considering Electrical Equipments and Circuits, Fire Safety in Handling Flammable and Explosive Materials, Fire Detection and Alarm System, Fixed Water Sprinkler System, Fire Hydrant, Portable Fire Extinguishers and Types of Portable Fire Extinguishers, Fire Drill and Fire Fighting Training.	18	10
5	**Industrial Safety, Hygiene and Occupational Health:** Industrial Hygiene & Health Definitions, Difference between Industrial Hygiene & Occupational Health, Work coordination between Industrial Hygienist, Role of Safety Officer and Factory Medical Officer, Occupational Health Hazards, Work Place Monitoring for Hazardous Chemicals, First Aid Facilities and Health Center, Personal Protection Equipment (PPE) and Emergency Equipment.	12	8

6	**Accident Analysis and Reporting:** Nature and Causes of Accidents, Accident Prevention and Control Techniques, Accident Reporting and Investigation, Accident Analysis and Recommendations.	**10**	**6**
	Total	**100**	**60**

Reference Books	
1.	**Indian Standard 14489:2018 - Standard for Occupational Health and Safety Audit.**
2.	**Industrial Accident Prevention (TextBook)** By H.W. Heinrich, Dan Petersen, and Nestor Roos | McGraw-Hill Book Company | 5th edition (1 January 1980), Pub. Year 1980
3.	**Industrial Safety: Concepts and Practices (TextBook)** By K.T. Kulkarni | Vidyarthi Griha Prakashan | NF, Pub. Year 2005
4.	**Fundamental of Industrial Safety & Health (TextBook)** By y Dr. K U Mistry | Shyamaraj Global Commerce (9 May 2022) | 2022, Pub. Year 2006
5.	**Occupational Safety Management & Engineering (TextBook)** By Willi Hammer | Pearson; 4th edition (1 October 1988) | 1 October 1988, Pub. Year 2022

Course Outcome

After Learning the Course the students shall be able to:

After learning the course, the students shall be able to:
1. Explain about Industrial Safety and Safety Audit.
2. Illustrate different Standards, Acts and Rules related to Management of Health & Safety and Safety Audit.
3. Discuss Physical and Chemical Hazards and Preventive Steps to avoid it.
4. Apply methods for Prevention and Extinguishing of Fire.
5. Discuss Importance of Industrial Hygiene and Occupational Health in Work Place.
6. Explain process of Accident Analysis and Reporting.

Course: MTech Prerequisite

Rationale :

Semester: 2

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					Total
					Internal Marks			External Marks		
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Seminar Hrs/Week	Credit	T	CE	P	T	P	
4	-	-	-	4	40	20	-	60	-	100

SEE - Semester End Examination, **T** - Theory, **P** - Practical

Course Content

W - Weightage (%) , **T** - Teaching hours

Sr.	Topics	W	T
1	**Unit I Introduction to IoT for Smart Cities** Definition and characteristics of smart cities IoT-based solutions in domains: Smart Home, Transport & Traffic management Smart city planning & infrastructure essentials Role of AI/ML/DL in IoT-enabled smart cities	18	8
2	**Unit II- Technologies for IoT** IoT communication technologies & recent protocols Secure IoT architectures overview Services powered by IoT within smart cities Cellular IoT, Cloud IoT platforms Case study: Compare MQTT, WebSocket & HTTP via Node-RED in smart-room setups	22	10
3	**Unit III - Smart Transportation and Energy Systems** Traffic management systems & sensor networks Electric vehicles (EVs) & EV charging infrastructure Renewable energy integration and smart distribution Smart grid concepts Image-processing for traffic control & bus movement analysis case study	18	8
4	**Unit IV –Smart Infrastructure and City Planning** Fundamentals of Smart Infrastructure Smart water management systems Infrastructure for Connectivity & Monitoring (Wi-Fi, 5G, LPWAN, NB-IoT infrastructure) Rainwater harvesting and solar-based automation	20	9
5	**Unit V - Security, Privacy, and Blockchain in IoT** Privacy and social values in smart urban environments IoT information security challenges Blockchain applications in IoT Case studies: smart homes, building, street-lighting, parking, irrigation, & food-supply chain traceability Threats and mitigation mechanisms	13	6
6	**Unit-VI Mini Project / Case Study**Applications & Lab-Based Work	9	4
	Total	**100**	**45**

Reference Books	
1.	**Internet of Things for Smart Cities** By Waleed Ejaz & Alagan Anpalagan | Springer, Pub. Year 2019
2.	**IoT for Smart Cities** By Ejaz & Anpalagan | Springer
3.	**Adrian McEwen, Hakim Cassimally, “Designing the Internet of things”, John Wiley and sons, 1stedition, 2014.**