MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

(Deemed to be University)

MADANAPALLE

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MASTER OF TECHNOLOGY

Computer Science & Engineering

Course Structure

&

Detailed Syllabi

For the students admitted to

Master of Technology in Computer Science & Engineering from the Academic Year 2025 – 26 Batch onwards

M.Tech Regular Two Year P.G. Degree Course

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

(Deemed to be University)

MADANAPALLE

M. Tech Two Year Curriculum Structure

Branch: Computer Science & Engineering

Total Credits	80 Credits for 2025 Admitted Batch onwards

R25 - Curriculum Structure
I Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PC	25MBCSETC01	Advanced Data Structures and Algorithms	3	0	0	3	3
2	PC	25MBCSETC02	Modern Database Management Systems	3	0	0	3	3
3	DE		**Discipline Elective-I** *(Refer ANNEXURE - I)*	3	0	0	3	3
4	DE		**Discipline Elective-II** *(Refer ANNEXURE - I)*	3	0	0	3	3
5	MC	25MBCOMMC01	Research Methodology and IPR	2	0	0	2	2
6	PC	25MBCSELC01	Software Defined Network Laboratory	0	0	4	4	2
7	PC	25MBCSELC02	Modern Database Management Systems Laboratory	0	0	4	4	2
8	SEC	25MBCSESC01	Data Science Using Python	1	0	2	3	2
9	MC	25MBCIVMC01	Disaster Management	2	0	0	2	0
Total				**17**	**0**	**10**	**27**	**20**

I Year II Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PC	25MBCSETC03	Advanced Machine Learning	3	0	0	3	3
2	PC	25MBCSETC04	Advanced Data Visualization Techniques	3	0	0	3	3
3	DE		**Discipline Elective-III** *(Refer ANNEXURE - I)*	3	0	0	3	3
4	DE		**Discipline Elective-IV** *(Refer ANNEXURE - I)*	3	0	0	3	3
5	OE		**Open Elective-I MOOCs** *(Refer ANNEXURE – II)*	2	0	0	2	2
6	PC	25MBCSELC03	Advanced Machine Learning Laboratory	0	0	4	4	2
7	PC	25MBCSELC04	Advanced Data Visualization Techniques Laboratory	0	0	4	4	2
8	SEC	25MBCSESC02	Prompt Engineering	1	0	2	3	2
Total				**15**	**0**	**10**	**25**	**20**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

II Year I Semester (Tentative Structure)

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PC	25MBCSETC05	Image and Video Analytics	3	0	0	3	3
2	PE		**Discipline Elective - V**	3	0	0	3	3
3	OE		**Open Elective-II** *(Refer ANNEXURE – II)*	3	0	0	3	3
4	SEC		**Skill Enhancement Course**	1	0	2	3	2
5	PR	25MBCSEIC01	Internship*	0	0	6	6	3
6	PR	25MBCSEPC01	Dissertation Phase I	0	0	20	20	10
Total				**10**	**0**	**28**	**38**	**24**

* 6 Weeks Internship during I Year II Semester Summer Break and to be evaluated in II Year I Semester

II Year II Semester (Tentative Structure)

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PR	25MBCSEPC02	Dissertation Phase II	0	0	32	32	16
Total				**0**	**0**	**32**	**32**	**16**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

ANNEXURE - I

LIST OF DISCIPLINE ELECTIVES

Discipline Elective – I (To be offered under Conventional Mode)		
Sl. No.	**Course Code**	**Course Title**
1.	25MBCSEDC01	Natural Language Processing
2.	25MBCSEDC02	Social Network Analysis
3.	25MBCSEDC03	Enterprise Cloud Computing
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

Discipline Elective – II (To be offered under Conventional Mode)		
Sl. No.	**Course Code**	**Course Title**
1.	25MBCSEDC04	Big Data Analytics
2.	25MBCSEDC05	Blockchain Technology
3.	25MBCSEDC06	DevOps
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

Discipline Elective – III (To be offered under Conventional Mode)		
Sl. No.	**Course Code**	**Course Title**
1.	25MBCSEDC07	Soft Computing Techniques
2.	25MBCSEDC08	Quantum Computing
3.	25MBCSEDC09	Cyber Security
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

Discipline Elective – IV (To be offered under Conventional Mode)		
Sl. No.	**Course Code**	**Course Title**
1.	25MBCSEDC10	Responsible AI
2.	25MBCSEDC11	Internet of Things
3.	25MBCSEDC12	Penetration Testing
Any other new Disciplinary Course which doesn't exist in the Curriculum can be appended in future.		

ANNEXURE - II

LIST OF OPEN ELECTIVE COURSES

Open Elective - I (To be offered under MOOC's Category from SWAYAM – NPTEL)		
Sl. No.	**Course Code**	**Course Title**
1.	25MBCIVOM01	Remote Sensing and GIS
2.	25MBCIVOM02	Sustainable Engineering Concepts and Life Cycle Analysis
3.	25MBMECOM01	Product Engineering and Design Thinking
4.	25MBMBAOM01	Innovation, Business Models and Entrepreneurship
Any other new Inter - Disciplinary Course offered by SWAYAM NPTEL which doesn't exist in the Curriculum can be appended in future.		

I Year I Semester

M. Tech Computer Science & Engineering

M. Tech I Year I Semester

25MBCSETC01 ADVANCED DATA STRUCTURES AND ALGORITHMS

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

This course aims to strengthen students' understanding of advanced data structures and algorithmic techniques for efficient problem solving. It enables them to analyse computational complexity, implement hierarchical and graph-based structures, and apply design strategies such as dynamic programming and greedy algorithms. Students will also explore NP-complete problems, equipping them with the skills to design, evaluate, and select appropriate algorithms for complex real-world applications.

Course Objectives:

This course enables students to

1. To understand the usage of algorithms in computing
2. To learn and use hierarchical data structures and its operations
3. To learn the usage of graphs and its applications
4. To select and design data structures and algorithms that is appropriate for problems
5. To study about NP Completeness of problems.

UNIT I ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS **9 hours**

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms-Program performance measurement - Recurrences: The Substitution Method – The Recursion Tree Method.

UNIT II HIERARCHICAL DATA STRUCTURES **9 hours**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B - trees – Basic operations on B-Trees – Deleting a key from a B-Tree.

UNIT III GRAPHS **9 hours**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm.

UNIT IV ALGORITHM DESIGN TECHNIQUES **9 hours**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

UNIT V NP COMPLETE AND NP HARD **9 hours**

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Design data structures and algorithms to solve computing problems.
CO2: Choose and implement efficient data structures and apply them to solve problems.
CO3: Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.
CO4: Design one's own algorithm for an unknown problem.
CO5: Apply suitable design strategy for problem solving.

Text Book(s)

1. S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2. Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013
3. T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.

Reference Books

1. Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009.
2. E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

M. Tech I Year I Semester

25MBCSETC02 MODERN DATABSE MANAGEMENT SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

This course introduces advanced concepts and practices in modern database management systems. It covers relational, SQL, NoSQL, and cloud-based database systems, emphasizing data modeling, indexing, transactions, concurrency control, and database security. Students learn query optimization with Web frameworks. Practical sessions focus on SQL, NoSQL databases, and database administration tools used in contemporary applications.

Course Objectives:

This course enables students to

1. Understand and analyse relational database management systems and indexing structures.
2. Apply query processing algorithms and optimization techniques for efficient database performance.
3. Apply transaction processing and concurrency control methods in real-world database systems.
4. Understand and apply the design principles of Object-Relational and NoSQL databases.
5. Evaluate and implement solutions for big data and graph databases.

UNIT I INTRODUCTION TO RDBMS AND RELATIONAL MODEL 9 hours

Overview of RDBMS – Storage and File Structures, Indexing and Hashing - Indexing Structures – Single and Multi-level indexes. Relational Algebra, Relational Calculus. Introduction, Integrity Constraints, Logical database design, Introduction to views.

UNIT II QUERY PROCESSING AND DATABASE TUNING 9 hours

Query Processing Optimization and Database Tuning: - Algorithms for Query Processing and Optimization- Physical Database Design and Tuning. Intermediate and Advanced SQL - Embedded SQL Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features.

UNIT III TRANSACTION PROCESSING 9 hours

Transactions Processing and Concurrency Control - Transaction Concept, Transaction model, Storage Structure, Transaction Atomicity and Durability, Transaction Isolation, Serializability - Lock based, time stamp based, optimistic, concurrency protocols, Deadlocks, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

UNIT IV OBJECT RELATIONAL DATA MODEL 9 hours

Object Relational Data Models – Complex Data Types, Inheritance, Nesting and Unnesting. NoSQL Databases – NoSQL Data Models, Comparisons of various NoSQL Databases. CAP Theorem, Storage Layout, Query models. Key-Value Stores. Document-databases – Apache CouchDB, MongoDB. Column Oriented Databases – Google's Big Table, Cassandra

UNIT V ADVANCED APPLICATION DEVELOPMENT AND RECENT TREND **9 hours**

Advanced Application Development – Connecting to MongoDB with Python, MongoDB query Language, Updating/Deleting documents in collection, MongoDB query operators. MongoDB and Python patterns – Using Indexes with MongoDB, GeoSpatial Indexing, Upserts in MongoDB. Document database with Web frameworks

Course Outcomes:

After completing this Unit, students will be able to

CO1: Describe the design and indexing mechanisms of RDBMS and their internal organization.
CO2: Implement and optimize queries using advanced SQL and tuning techniques.
CO3: Manage transactions effectively by implementing concurrency control and recovery mechanisms.
CO4: Analyse and utilize Object-Relational and NoSQL database models for data management.
CO5: Evaluate big data and graph database solutions and apply them to real-world scenarios.

Text Book(s)

1. Ramesh Elmasri and Shamkant B Navathe, “Fundamentals of Database Systems”, Fifth Edition, Pearson Educaton India, 2008
2. Silberschatz A, Korth H F and Sudharshan S, “Database System Concepts”, Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.
3. Andreas Meier, Michael Kaufmann, “SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management”, Springer Verlag 2019

Reference Books

1. Hector Garcia-Molina, Jeff Ullman and Jennifer Widom, “Database Systems: The Complete Book”, Pearson, 2011.
2. Raghu Ramakrishnan and Johannas Gehrke, “Database Management Systems”, Third Edition, McGraw-Hill, 2003.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

M. Tech I Year I Semester

25MBCOMMC01 RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

Pre-requisite Nil

Course Description:

This course aims to provide students with a comprehensive understanding of research methodology and the principles and practices of intellectual property rights (IPR). The course will equip students with the skills needed to design, conduct, and evaluate research effectively while also understanding the legal and ethical considerations surrounding intellectual property.

Course Objectives:

To impart knowledge on

1. Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
2. Intellectual property rights, patenting and licensing

UNIT I RESEARCH PROBLEM FORMULATION 9 hours

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9 hours

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9 hours

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9 hours

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR, IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9 hours

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

Course Outcomes:

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

Text Book(s)

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, "Research methodology for natural sciences", IISc Press, Kolkata, 2022.
3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.

Reference Books

1. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

M. Tech I Year I Semester

25MBCSELC01 SOFTWARE DEFINED NETWORK LABORATORY

L	T	P	C
0	0	4	2

Pre-requisite NIL

Course Description:

This course introduces Software Defined Networking (SDN) using tools like Mininet, OmniNet, and vim-emu. Students will learn to design, monitor, and program network topologies and services using OpenFlow and APIs.

Course Objectives:

1. Set up virtualized SDN environments for testing network scenarios.
2. Learn to use Mininet and OmniNet for network emulation.
3. Capture and analyze OpenFlow messages with Wireshark.
4. Build SDN applications using Northbound APIs for tasks like routing and firewalling.
5. Deploy end-to-end services with VNFs using vim-emu.

List of Experiments:

1. Setting up the virtualized SDN environment
2. Introduction to Mininet & Omni Net
3. Introduction to Openflow
4. Create a simple mininet topology with SDN controller and use Wireshark to capture and visualize the OpenFlow messages such as OpenFlow FLOW MOD, PACKET IN, PACKET OUT etc.
5. Create a SDN application that uses the Northbound API to program flow table rules on the switch for various use cases like L2 learning switch, Traffic Engineering, Firewall etc.
6. Create a simple end-to-end network service with two VNFs using vim-emu

Course Outcomes:

After completion of the course, students will be able to

CO1: Configure and manage SDN test environments.

CO2: Create and simulate network topologies.

CO3: Monitor and interpret OpenFlow traffic.

CO4: Program flow rules for various network applications.

CO5: Implement network services using virtual functions.

Text Books:

1. Goransson, P., Black, C. and Culver, T., 2016. Software defined networks: a comprehensive approach. Morgan Kaufmann
2. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison-Wesley, 2011 (ISBN-10: 0321512944. ISBN-13: 9780321512949).

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

M. Tech I Year I Semester

25MBCSELC02 MODERN DATABASE MANAGEMENT SYSTEMS LABORATORY

L	T	P	C
0	0	4	2

Pre-requisite

Course Description:

This Modern Database Management Systems laboratory provides hands-on experience with advanced database concepts, including relational database design, query optimization, transaction management, and recovery techniques. Students work with modern database technologies such as Object-Relational DBMS, NoSQL databases (MongoDB, Cassandra, CouchDB), and explore indexing, tuning, and advanced SQL features. The course also covers application development using Python with MongoDB and web framework integration, preparing students for research and industry-oriented database solutions.

Course Objectives:

1. Understand and perform relational database design and SQL implementation.
2. Apply transaction management, concurrency control, and recovery techniques in database systems.
3. Analyse indexing, tuning, and query optimization methods for enhancing database performance
4. Evaluate Object-Relational and NoSQL database models including MongoDB and Cassandra
5. Create database applications integrating modern programming languages like Python with NoSQL systems.

List of Experiments:

1. **Installation and Configuration of RDBMS**
   Install MySQL/PostgreSQL/Oracle and configure client-server environment
2. **Storage Structures and Indexing**
   Demonstrate file structures, single-level and multi-level indexing, and hashing.
3. **Relational Algebra and Relational Calculus**
   i. Write SQL equivalents for relational algebra operations (SELECT, PROJECT, JOIN, etc.).
   ii. Practice tuple and domain relational calculus queries.
4. **Transaction Management**
   Implement ACID properties, isolation levels, and save points in SQL.
5. **Concurrency Control Mechanisms**
   Simulate lock-based, timestamp-based, and optimistic concurrency protocols.
6. **NoSQL Database Operations**
   i. Installation and setup of MongoDB and CouchDB.
   ii. Create collections, perform CRUD operations, and explore CAP Theorem with query models.
7. **Cassandra Database Operations**
   Install Cassandra and execute Create, Alter, Drop, Insert, Update, Delete, and Select queries.
8. **MongoDB with Python Integration**
   i. Connect MongoDB with Python using PyMongo.
   ii. Perform insert, update, delete, and retrieve operations.

9. **Indexing and Advanced Query Operators in MongoDB**
   Implement GeoSpatial Indexing, Upserts, and query operators ($gt, $lt, $in, $regex, etc.).
10. **Web Framework Integration**
    Develop a simple web application using Python Flask/Django connected to MongoDB.

Course Outcomes:

Upon successful completion, students will be able to:

CO1: Describe normalized relational schemas and perform SQL operations effectively.
CO2: Implement and manage ACID properties, isolation levels, and concurrency control mechanisms.
CO3: Analyse database performance and execute tuning strategies to optimize query processing
CO4: Assess the concepts and perform operations on Object-Relational and NoSQL databases.
CO5: Develop and deploy applications that integrate Python with MongoDB for advanced database functionalities.

Text Books:

1. Silberschatz A, Korth H F and Sudharshan S, "Database System Concepts", Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.
2. Andreas Meier, Michael Kaufmann, "SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management", Springer Verlag 2019
3. Ramez Elmasri & Shamkant B. Navathe – *Fundamentals of Database Systems* 3rd Edition, Addison-Wesley,Year: 2000 .

References Books:

1. Raghu Ramakrishnan and Johannas Gehrke, "Database Management Systems", Third Edition, McGraw-Hill, 2003.
2. Hector Garcia-Molina, Jeff Ullman and Jennifer Widom, "Database Systems: The Complete Book", Pearson, 2011

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

M. Tech I Year I Semester

25MBCSESC01 DATA SCIENCE USING PYTHON

L	T	P	C
1	0	2	1

Pre-requisite PYTHON Programming

Course Description:

This course is designed to equipping students to be able to use python programming for solving data science problems.

Course Objectives:

This course enables students to

1. To train the students in solving computational problems.
2. To elucidate solving mathematical problems using Python programming language.
3. To understand the fundamentals of Python programming concepts and its applications.
4. Practical understanding of building different types of models and their evaluation.

UNIT I INTRODUCTION TO DATA SCIENCE 6 hours

Introduction to Data Science and its importance - Data Science and Big data-, The life cycle of Data Science- The Art of Data Science - Work with data – data Cleaning, data Managing, data manipulation. Establishing computational environments for data scientists using Python with IPython and Jupyter.

a. Launch the IPython shell and the Jupyter notebook.
b. Write a python script to control the behaviour of IPython using magic commands.
c. Create a file called hello.py
d. Replace the missing values with the expected, or mean income of custdata dataset.
e. Import data in python.

UNIT II INTRODUCTION TO NUMPY 6 hours

NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray- Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-SortingUnique and Other Set Logic.

a. Create NumPy arrays from Python Data Structures, Intrinsic NumPy objects and Random Functions.
b. Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining and Splitting.
c. Computation on NumPy arrays using Universal Functions and Mathematical methods.
d. Import a CSV file and perform various Statistical and Comparison operations on rows/columns.
e. Load an image file and do crop and flip operation using NumPy Indexing.
f. Write a program to compute summary statistics such as mean, median, mode, standard deviation and variance of the given different types of data.

UNIT III DATA MANIPULATION WITH PYTHON 6 hours

Introduction to pandas Data Structures: Series, DataFrame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.

a. Create Pandas Series and DataFrame from various inputs.

b. Import any CSV file to Pandas DataFrame and perform the following:

i. Visualize the first and last 10 records
ii. Get the shape, index and column details.
iii. Select/Delete the records(rows)/columns based on conditions.
iv. Perform ranking and sorting operations.
v. Do required statistical operations on the given columns.
vi. Find the count and uniqueness of the given categorical values.
vii. Rename single/multiple columns.

UNIT IV DATA CLEANING, PREPARATION AND VISUALIZATION 6 hours

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

a. Import any CSV file to Pandas DataFrame and perform the following:

i. Handle missing data by detecting and dropping/ filling missing values.
ii. Transform data using apply() and map() method.
iii. Detect and filter outliers.
iv. Perform Vectorized String operations on Pandas Series.
v. Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.

UNIT V MACHINE LEARNING USING PYTHON 6 hours

Introduction Machine Learning: Categories of Machine Learning algorithms, Dimensionality reduction-Introducing ScikitApplication: Exploring Hand-written Digits. Feature Engineering Naive Bayes Classification - Linear Regression - kMeans Clustering.

a. Write a program to demonstrate Linear Regression analysis with residual plots on a given data set.
b. Write a program to implement the Naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
c. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions using Python ML library classes.
d. Write a program to implement k-Means clustering algorithm to cluster the set of data stored in .CSV file. Compare the results of various "k" values for the quality of clustering.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Understand the Data Science Lifecycle and its Practical application using Python.

CO2: Demonstrate Data Manipulation and Statistical Analysis using Numpy.

CO3: Utilize pandas data structures such as Series and Data Frame, focusing on essential functionality, data manipulation, statistics, and reading/writing text .

CO4: Infer the handling of missing values, transformations, outlier filtering, string manipulation, and plotting with pandas: line, bar, histogram, and scatter plots.

CO5: Examine ML algorithms through dimensionality reduction, Scikit application for hand-written digit exploration, feature engineering, Naive Bayes classification, linear regression, and k- means clustering.

Text Book(s)

1. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition,2018.
2. Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly, 2017.
3. Kottwitz S, "LaTeX Cookbook", First Edition, Packt Publishing, Year: 2015.

Reference Books

1. Y. Daniel Liang, "Introduction to Programming using Python", Pearson,2012.
2. Francois Chollet, Deep Learning with Python, 1/e, Manning Publications Company, 2017.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Mandatory Course

25MBCIVMC01 DISASTER MANAGEMENT

L	T	P	C
2	0	0	0

Course Objectives:

Upon the completion of subject student will be able to-

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches,
5. Planning and programming in different countries, particularly their home country or the countries they work in

UNIT-I DISASTER CLASSIFICATION **6 hours**

Disaster: definition, factors and significance; difference between hazard and Disaster; natural disaster: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches; man-made disasters: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts

UNIT-II REPERCUSSIONS OF DISASTERS **6 hours**

Economic damage, loss of human and animal life, destruction of ecosystem. **Disaster Prone Areas in India:** Study of seismic zones; areas prone to floods and droughts, landslides and Avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami.

UNIT-III DISASTER PREPAREDNESS AND MANAGEMENT **6 hours**

Preparedness: monitoring of phenomena triggering a disaster or hazard; Evaluation of risk: application of remote sensing, data from meteorological and Other agencies, media reports: governmental and community preparedness.

UNIT-IV RISK ASSESSMENT **6 hours**

Disaster risk: concept and elements, disaster risk reduction, global and national disaster risk situation. Techniques of risk assessment, global co-operation in risk assessment and warning.

UNIT-V DISASTER MITIGATION **6 hours**

Meaning, concept and strategies of disaster mitigation, emerging trends in Mitigation. Structural mitigation and non-structural mitigation, programs of Disaster mitigation in India.

Course outcomes:

After the completion of the subject following outcomes can be achieved-

CO1: Students will be able to understand disaster and its types in general.

CO2: They will understand the post disaster damage in terms of both like and commodity.

CO3: They will have clear picture of disaster-prone zones.

CO4: They will be able to understand the pre and post disaster preparedness needed to mitigate the disaster impact in large scale.

CO5: Student will also understand to quantify the risk in terms of monetary for both commodity and life.

CO6: Student will also learn the structural and non-structural measures for risk mitigation

Reference Books:

1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
2. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
3. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
4. Goel S. L., Disaster Administration And Management Text and Case Studies" ,Deep&Deep Publication Pvt. Ltd., New Delhi

Mode of Evaluation: Assignments, Mid Term Tests

I Year II Semester

M. Tech I Year II Semester

25MBCSETC03 ADVANCED MACHINE LEARNING

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

Advanced Machine Learning course focuses on cutting-edge techniques beyond the basics of supervised and unsupervised learning. It covers deep learning architectures, reinforcement learning, transfer learning, and generative models. The course emphasizes optimization, scalability, and handling real-world complex datasets. Students gain hands-on experience through projects involving computer vision, NLP, and advanced AI applications.

Course Objectives:

This course enables students to

1. To explain mathematical concepts of machine learning.
2. To know ensemble methods in machine learning.
3. To apply reinforcement learning concepts in real-world scenarios.
4. To implement machine learning techniques on real datasets.
5. To build machine learning algorithms using cloud APIs.

UNIT I MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING **9 hours**

Probability and Axioms - Conditional Probability and Bayes' Theorem - Random Variables and Distributions - Expectation, Variance, and Covariance - Gaussian and Multivariate Gaussian Distribution - Law of Large Numbers and Central Limit Theorem - Descriptive Statistics (Mean, Median, Mode, Std Dev) - Confidence Intervals and Hypothesis Testing.

UNIT II ENSEMBLE METHODS **9 hours**

Bagging and Random Forest – Bootstrap and aggregation – Boosting methods and Ada boost – AdaBoost ensemble- Cat Boost.

UNIT III REINFORCEMENT LEARNING **9 hours**

Introduction, formal framework, different components to learn a policy, value-based methods for RL,Q-learning, fitted Q-learning, Deep Q-networks, double DQN, dueling network architecture, distributional DQN, Multi step learning, concepts of generalization, feature selection, bias-over fitting tradeoff .

UNIT IV MODEL EVALUATION AND HYPER PARAMETER TUNING **9 hours**

Streamlining workflows with pipelines, K-fold cross validation, Model performance measures, debugging algorithms with learning and validation curves, fine-tuning machine learning models via grid search, looking at different performance evaluation metrics, ranking metrics,

Classification metrics, regression metrics, Hold-out validation.

UNIT V MACHINE LEARNING DEPLOYMENT **9 hours**

Serializing fitted scikit – learn estimators, setting up a SQLite database for data storage, developing web application with Flask, turning the classifier into a web application, turning a regression problem into a web application, pickle model, deploying web application on to a public server, Cloud deployment using AWS and Google.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Apply probability and statistics for machine learning.

CO2: Analyze ensemble methods to improve model performance.

CO3: Develop reinforcement learning models with Q-learning and DQNs.

CO4: Apply evaluation metrics and hyperparameter tuning for model optimization.

CO5: Deploy machine learning models as web and cloud applications.

Text Book(s)

1. Master Machine Learning Algorithms: Discover How They Work and Implement Them From Scratch, Jason Brownlee, Machine Learning Mastery, 2016
2. Python: Deeper Insights into Machine Learning, By Sebas an Raschka , David Julian, John Hearty Birmingham, Packt publishing, 2016.

Reference Books

1. Introduction to Machine Learning with Python: A Guide for Data Scien sts, by Andreas C. Mueller, Sarah Guido, 1 st Edi on, Published by O'REILLY, 2016.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

M. Tech I Year II Semester

25MBCSETC04 ADVANCED DATA VISUALIZATION TECHNIQUES

L	T	P	C
3	0	0	3

Course Description:

Advanced Data Visualization is about the art and science of visualizing data. Three themes (what, why, and how) will run alongside each other as we cycle through the course. In "what" we focus on specific types of visualizations for a particular purpose, "how" we focus on the process – each visualization starts with and "why" we discuss the theory that ties the "how" and the "what" together, often focusing on the grammar of graphics.

Course Objectives:

1. To understand the various types of data, apply and evaluate the principles of data visualization.
2. Acquire skills to apply visualization techniques to a problem and its associated dataset.
3. To apply structured approach to create effective visualizations from the massive dataset using various visualization tools.

UNIT I BASICS OF DATA VISUALIZATION 9 hours

Overview of data visualization - Data Abstraction - Task Abstraction - Dimensions and Measures - Analysis: Four Levels for Validation. Statistical charts (Bar Chart - stacked bar chart – Line Chart - Histogram - Pie chart - Frequency Polygon - Box plot - Scatter plot - Regression curves.) Information visualization – effective data analysis – traits of meaningful data – visual perception – making abstract data visible – building blocks of information visualization – analytical interaction – analytical navigation – optimal quantitative scales – reference lines and regions – trellises and crosstabs – multiple concurrent views – focus and context – details on demand – over-plotting reduction – analytical patterns – pattern examples.

UNIT II DATA VISUALIZATION TOOLS 9 hours

Introduction to various data visualization tools - Scalar and point techniques - vector visualization techniques - multidimensional techniques - visualizing cluster analysis – K-means and Hierarchical Cluster techniques. Time Series data visualization – Text data visualization – Spatial Data Visualization

UNIT III NETWORK VISUALIZATION 9 hours

Networks and Trees - Heat Map – Tree Map - Map Color and Other Channels Manipulate View - Visual Attributes- Multivariate data visualization – Geometric projection techniques - Icon-based techniques - Pixel-oriented techniques - Hierarchical techniques - Scatterplot matrix - Hyper box - Trellis display - Parallel coordinates.

UNIT IV INTRODUCTION TO DASHBOARDS 9 hours

Dashboard – Introduction– Taxonomies- User Interaction- Organizational Functions-Dashboard Design – Worksheets - Workbooks – Workbook Optimization - Protection and common mistakes. Dashboard creation using visualization tool use cases: Finance-marketing-insurance-healthcare.

UNIT V PLOTTING GEOSPATIAL VISUALIZATION 9 hours

Plotting Geospatial Data: Introduction to Geoplotlib, Design Principles of Geoplotlib, Geospatial Visualizations, Plotting Geospatial Data on a Map Web-Based Visualizations: Concepts of Bokeh, Interfaces-Plotting and Model Interfaces, Output, Bokeh Server, Presentation, Integrating – HTML Document and Bokeh Applications.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Understand the different data types, visualization types to bring out the insight
CO2: Demonstrate the analysis of large dataset using various visualization techniques and tools
CO3: Relate the visualization towards the problem based on the dataset to analyse and bring out valuable insight on large dataset.
CO4: Design visualization dashboard to support the decision making on large scale data.
CO5: Apply visualization techniques for various Geospatial data analysis tasks

Text Book(s)

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
2. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United States, 2015.

Reference Books

1. Mario Dobler, Tim Grobmann, “Data Visualization with Python”, O’Reilly, First Edition, 2019
2. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

M. Tech I Year II Semester

25MBCSELC03 ADVANCED MACHINE LEARNING LABORATORY

L	T	P	C
0	0	4	2

Pre-requisite

Course Description:

Advanced Machine Learning course provides an in-depth study of modern machine learning techniques, including deep learning, reinforcement learning, ensemble methods, and Bayesian learning. It emphasizes practical implementation using Python and libraries such as TensorFlow, Keras, and Scikit-learn, with applications in computer vision, natural language processing, and healthcare analytics. Students will gain hands-on experience through real-world datasets, lab experiments, and projects that foster critical thinking and problem-solving. The course also introduces cloud-based model deployment, preparing students for both research and industry applications.

Course Objectives:

1. To impart knowledge of advanced machine learning algorithms and their applications.
2. To develop skills in implementing deep learning, ensemble, and reinforcement learning techniques.
3. To enable students to analyse and solve real-world problems using machine learning on large datasets.
4. To introduce cloud-based tools and frameworks for building and deploying ML models.

List of Experiments:

1. Train an SVM model to classify handwritten digits (MNIST dataset) and evaluate its accuracy compared to logistic regression.
2. Build and train a feedforward neural network using Python and Tensor Flow/Keras for a classification task.
3. Implement CNNs for image classification using datasets such as CIFAR-10 or MNIST
4. Build RNN/LSTM models for sequential data (e.g., text or time series prediction).
5. Implement bagging and Random Forest classifiers and compare performance with single decision trees.
6. Implement K-means and hierarchical clustering for pattern discovery in unlabelled data
7. Implement Apriori or FP-growth algorithms to generate association rules from transactional data
8. Implement PCA for visualization and dimensionality reduction on high-dimensional datasets.
9. Implement Q-learning or Deep Q-Networks (DQN) for solving a simple game or decision-making problem.
10. Perform feature engineering, extract relevant features, and deploy a trained ML model using a cloud API (e.g., Google Cloud ML, AWS Sagemaker, or Azure ML).

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain advanced concepts and methods in machine learning.
CO2: Apply deep learning, ensemble, and reinforcement learning techniques to practical problems.
CO3: Implement and evaluate machine learning models on real-world datasets.
CO4: Deploy machine learning solutions using cloud APIs and platforms.

Text Books:

1. Master Machine Learning Algorithms: Discover How They Work and Implement Them From Scratch, Jason Brownlee, Machine Learning Mastery, 2016
2. Python: Deeper Insights into Machine Learning, By Sebas an Raschka , David Julian, John Hearty Birmingham, Packt publishing, 2016.

References Books:

1. Introduction to Machine Learning with Python: A Guide for Data Scien sts, by Andreas C. Mueller, Sarah Guido, 1 st Edi on, Published by O'REILLY, 2016.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

M. Tech I Year II Semester

25MBCSELC04 ADVANCED DATA VISUALIZATION TECHNIQUES LABORATORY

L	T	P	C
0	0	4	2

Pre-requisite

Course Description:

This course offers hands-on experience in advanced techniques for visualizing complex and multidimensional datasets using modern tools. It focuses on creating interactive, meaningful, and insightful visual representations to support analysis and decision-making.

Course Objectives:

1. To understand the fundamental principles, theories, and techniques of data visualization.
2. To learn and apply various statistical, multivariate, and network visualization methods.
3. To gain practical skills in using advanced visualization tools and libraries.
4. To design and develop interactive dashboards and visual analytics applications.
5. To apply geospatial and web-based visualization techniques for real-world datasets.

List of Experiments:

1. Implement bar chart, line chart, histogram, pie chart, and scatter plot on a real dataset.
2. Generate boxplot, regression curve, and frequency polygon using Seaborn/Matplotlib.
3. Perform K-Means and Hierarchical clustering, visualize results in 2D/3D with colored clusters.
4. Visualize time series data (stock/weather dataset) with trends, seasonality, and rolling averages.
5. Process a text corpus, generate word frequency bar chart and word cloud.
6. Visualize a social or organizational network graph using NetworkX, showing nodes, edges, and centrality.
7. Use parallel coordinates, scatterplot matrix, and heatmap on a multidimensional dataset (e.g., Iris/Titanic).
8. Build an interactive dashboard (Tableau/Power BI/Plotly Dash/Bokeh) for finance/marketing/healthcare data.
9. Plot geospatial data (e.g., earthquakes, population density, COVID-19 cases) on a map using Geoplotlib.
10. Create an interactive Bokeh web visualization with zoom, hover, and filters, integrated into an HTML page.

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply basic statistical visualization methods to analyze data.

CO2: Use tools to visualize multidimensional, time-series, and text data.

CO3: Create network and multivariate visualizations for complex datasets.

CO4: Design dashboards for real-world applications.

CO5: Develop geospatial and web-based interactive visualizations.

Text Books:

1. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021
2. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United states, 2015.
3. Ben Fry, Visualizing Data, 1st edition, O'Reilly Media, United States, 2008.

References Books:

1. Dr. Chun-hauh Chen, W. K. Hardle, A. Unwin, Handbook of Data Visualization, 1st edition, Springer publication, Germany, 2008.
2. James, G. et al. *An Introduction to Statistical Learning with Applications in R*. Springer, 2021.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

M. Tech I Year II Semester

25MBCSESC02 PROMPT ENGINEERING

	L	T	P	C
Pre-requisite NIL	**1**	**0**	**2**	**2**

Course Description

This course delves into prompt engineering principles, strategies, and best practices, a crucial aspect in shaping AI models' behaviour and performance. Understanding Prompt Engineering is a comprehensive course designed to equip learners with the knowledge and skills to effectively generate and utilize prompts in natural language processing (NLP) and machine learning (ML) applications. This course delves into prompt engineering principles, strategies, and best practices, a crucial aspect in shaping AI models' behaviour and performance.

Course Objectives:

1. Understanding the fundamentals and evolution of prompt engineering.
2. Gaining the ability to craft effective closed-ended, open-ended, and role-based prompts.
3. Learning to probe and stress-test AI models for bias and robustness.
4. Applying prompt optimization techniques and performance evaluation methods.
5. Mitigating bias and promoting ethical prompting practices in NLP/ML systems.

UNIT I Introduction to Prompt Engineering 6 hours

- *Foundations of Prompt Engineering*
  - Overview of prompt engineering and its significance in NLP and ML.
  - Historical context and evolution of prompt-based approaches.
- *Closed-Ended Prompts*
  - Under standing and creating prompts for specific answers.
  - Applications in question- answering systems.
- *Open-Ended Prompts*
  - Crafting prompts for creative responses.
  - Applications in language generation models.

UNIT II Strategies for Effective Prompting 6 hours

- *Probing Prompts*
  - Designing prompts to reveal model biases.
  - Ethical considerations in using probing prompts.
- *Adversarial Prompts*
  - Creating prompts to stress-test models.
  - Enhancing robustness through adversarial prompting.

UNIT III Fine-Tuning and Optimizing with Prompts 6 hours

- *Fine-Tuning Models with Prompts*
  - Techniques for incorporating prompts during model training.
  - Balancing prompt influence and generalization.
- *Optimizing Prompt Selection*
  - Methods for selecting optimal prompts for specific tasks.
  - Customizing prompts based on model behavior.

UNIT IV Evaluation and Bias Mitigation 6 hours

- *Evaluating Prompt Performance*
  - Metrics and methodologies for assessing model performance with prompts.
  - Interpreting and analyzing results.
- *Bias Mitigation in Prompt Engineering*
  - Strategies to identify and address biases introduced by prompts.

UNIT V Real-World Applications and Case Studies 6 hours

- *Case Studies in Prompt Engineering using ChatGPT, Gemini, Microsoft Copilot*
  - *Exploration of successful implementations and challenges in real-world scenarios.*
  - *Guest lectures from industry experts sharing their experiences.*

Course Outcomes:

After completion of the course, students will be able to

CO1: Describe the core principles and evolution of prompt engineering in NLP and ML.
CO2: Design effective closed-ended and open-ended prompts for specific language tasks.
CO3: Apply strategies like probing, adversarial, and optimized prompting to evaluate and enhance model behavior.
CO4: Assess prompt performance using metrics and implement bias mitigation techniques.
CO5: Analyze real-world applications and case studies involving tools like ChatGPT, Gemini, and Microsoft Copilot.

Text Books:

1. "Prompt Engineering in Action" – Danny D. Sullivan

2. "The Art of Prompt Engineering with Chat GPT: A Hands-On Guide" – Nathan Hunter.

Reference Books:

1. "Prompt Engineering in Practice" – *Michael F. Lewis*

2. "Mastering AI Prompt Engineering: The Ultimate Guide for Chat GPT Users" – *Adriano Damiao*

3. "Writing AI Prompts For Dummies" – *Stephanie Diamond and Jeffrey Allan*

4. "Prompt Engineering Guide" (Online Resource) – *promptingguide.ai*

Online Learning Resources:

1. https://www.udemy.com/course/understanding-prompt-engineering/?couponCode=NVDINCTA35TRT

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

DISCIPLINE ELECTIVES

Discipline Elective – I

25MBCSEDC01 NATURAL LANGUAGE PROCESSING

L	T	P	C
3	0	0	3

Pre-requisite Basic knowledge of Operating Systems

Course Description:

This NLP course provides a rigorous, theory-first pathway from linguistic foundations and classical statistical models to modern neural and transformer methods, emphasizing evaluation and reproducibility. It spans morphology, syntax, semantics, and discourse, alongside core tasks such as tagging, parsing, machine translation, question answering, and summarization with formal treatments of probabilistic and neural models. Learners analyse sequence labelling, embeddings, attention, and transformers, including pretraining and fine-tuning paradigms for diverse applications.

Course Objectives:

This course enables students to

1. To provide foundational knowledge of linguistics and core NLP tasks.
2. To understand and analyse syntactic structures and parsing methods.
3. To apply semantic and discourse modelling techniques to text understanding.
4. To explore probabilistic and neural models for modern NLP applications.
5. To gain insights into machine translation, large language models, and ethical issues in NLP.

UNIT I NLP FOUNDATIONS AND LINGUISTICS 9 hours

NLP tasks and applications - linguistic levels (morphology - syntax - semantics - pragmatics) - text normalization and tokenization theory - morphology and finite-state methods - word types and distributions - corpora and annotation standards - evaluation metrics and test design - statistical language modeling overview - n-gram assumptions and smoothing families.

UNIT II SYNTAX AND PARSING 9 hours

Parts of speech and tagging formalisms - HMM and CRF tagging models (theory) - context-free grammars and probabilistic CFGs - dependency vs constituency theories - classic parsing algorithms (CKY - Earley - chart parsing) - lexicalized and data-driven parsing - ambiguity and disambiguation criteria - treebanks and annotation schemes - multilingual and domain adaptation issues

UNIT III SEMANTICS AND DISCOURSE 9 hours

Lexical semantics and sense inventories - distributional meaning and embeddings (theory) - compositional semantics and entailment - semantic role labeling frameworks - coreference and anaphora resolution - discourse structure and coherence models - text classification and sentiment theory - topic models and document semantics - summarization objectives and evaluation.

UNIT IV PROBABILISTIC AND NEURAL MODELS 9 hours

Maximum likelihood and EM in NLP - discriminative log-linear models - sequence labeling as structured prediction - word and subword embeddings (Word2Vec - GloVe - BPE theory) - attention mechanisms (conceptual) - transformer architecture principles - pretraining objectives (LM - MLM - seq2seq) - fine-tuning paradigms and generalization - uncertainty, calibration, and evaluation limits.

UNIT V MACHINE TRANSLATION AND LLM ERA TOPICS 9 hours

Classical MT (rule-based - phrase-based SMT) - alignment and decoding theory - neural MT objectives and constraints - cross-lingual representation theory - question answering and information extraction (theory) - retrieval-augmented generation concepts - prompt design and in-context learning theory - ethics, bias, and safety in NLP - reproducibility and benchmarking practices

Course Outcomes:

This course enables students able to,
CO1: Apply linguistic concepts and statistical models in NLP.
CO2: Analyze syntactic structures using parsing methods.
CO3: Apply semantic and discourse techniques for text tasks.
CO4: Use probabilistic and neural models for NLP applications.
CO5: Analyze machine translation and LLM-based approaches.

Text Book(s)

1. Jurafsky D and Martin J H, "Speech and Language Processing", 3rd Edition (draft), Prentice Hall, Year: 2023.
2. Manning C D and Schütze H, "Foundations of Statistical Natural Language Processing", First Edition, MIT Press, Year: 1999.
3. Eisenstein J, "Introduction to Natural Language Processing", First Edition, MIT Press, Year: 2019.

Reference Books

1. Goldberg Y, "Neural Network Methods for Natural Language Processing", First Edition, Morgan & Claypool, Year: 2017.
2. Tunstall L, von Werra L and Wolf T, "Natural Language Processing with Transformers", Revised Edition, O'Reilly Media, Year: 2022.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – I

25MBCSEDC02 SOCIAL NETWORK ANALYSIS

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

This course introduces the theoretical foundations and analytical techniques for studying social networks. Topics include network measures, growth models, link analysis, community detection, and link prediction. Applications are discussed in areas such as social media, business, health, and information systems. The emphasis is on conceptual understanding, mathematical models, and interpretation of network structures.

Course Objectives:

This course enables students to

1. To understand the fundamental concepts, theories, and principles of social network structures and dynamics.
2. To learn methods for collecting, preprocessing, and representing network data using appropriate models and tools.
3. To apply key network metrics and analytical techniques for identifying patterns, communities, and influential entities.
4. To develop skills in visualizing and interpreting network structures for various real-world applications.
5. To analyse the ethical, social, and practical implications of social network analysis.

UNIT I NETWORKS AND SOCIETY 9 hours

What is Social Network Analysis, why do We Study Social Networks, Applications of Social Network Analysis, Preliminaries, Types of social networks, Three Levels of Social Network Analysis. Network Measures - Network Basics, Node Centrality, Assortative, Transitivity and Reciprocity, Similarity, Degeneracy.

UNIT II NETWORK GROWTH MODELS 9 hours

Properties of Real-World Networks, Random Network Model, Ring Lattice Network Model, Watts-Strogatz Model, Preferential Attachment Model, Price's Model, Local-world Network Growth Model, Network Model with Accelerating Growth, Aging in Preferential Attachment.

UNIT III LINK ANALYSIS 9 hours

Applications of Link Analysis, Signed Networks, Strong and Weak Ties, Link Analysis Algorithms, PageRank, Personalised PageRank, DivRank, SimRank, PathSIM.

UNIT IV COMMUNITY STRUCTURE IN NETWORKS 9 hours

Applications of Community Detection, Types of Communities, Community Detection Methods, Disjoint Community Detection, Overlapping Community Detection, Local Community Detection, Community Detection vs Community Search, Evaluation of Community Detection Methods.

UNIT V LINK PREDICTION 9 hours

Applications of Link Prediction, Temporal Changes in a Network, Problem Definition, Evaluating Link Prediction Methods, Heuristic Models, Probabilistic Models, Supervised Random Walk, Information-theoretic Model, Latest Trends in Link Prediction.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Illustrate the core concepts of Social Network Analysis and its levels of study.
CO2: Demonstrate the different network growth models for real-world networks
CO3: Apply algorithms of PageRank and SimRank to analyse and interpret link relationships.
CO4: Apply community detection methods and evaluating their effectiveness in real-world scenarios.
CO5: Analyse heuristic, probabilistic, and supervised models to predict network link formations and changes.

Text Book(s)

1. Tanmoy Chakraborty, "Social Network Analysis" Wiley India Pvt. Ltd., 2021

Reference Books

1. Albert-Laszlo Barabasi, "Network Science", Cambridge University Press, 2016

2. Stanley Wasserman, Katherine Faus, "Social Network Analysis: Methods and Applications", Cambridge University Press, 1994

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_cs117/preview
2. https://social-network-analysis.in/
3. https://www.coursera.org/learn/social-network-analysis

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – I

25MBCSEDC03 ENTERPRISE CLOUD COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite Basic knowledge of Operating Systems

Course Description:

This course provides comprehensive knowledge on Enterprise Cloud Computing, covering foundational concepts, architecture, and deployment models. Topics include cloud service models (IaaS, PaaS, SaaS), cloud virtualization, storage, and security in cloud environments. Students will explore cloud infrastructure design, distributed systems, and the latest advances in cloud technologies including microservices and container orchestration. Emphasis is placed on understanding cloud economics, cloud service management, and enterprise-grade cloud solutions. By the end of the course, students will be capable of designing, implementing, and managing scalable and secure cloud applications suitable for enterprises.

Course Objectives:

This course enables students to

1. To Understand the fundamentals of cloud computing and enterprise cloud architecture.
2. To Learn about virtualization techniques and cloud service models.
3. To Explore cloud storage solutions, data management, and security aspects.
4. To Study cloud application development including microservices and containerization.
5. To Gain skills to plan and manage cloud-based IT strategies for enterprises.

UNIT I INTRODUCTION TO CLOUD COMPUTING 9 hours

Definition, Characteristics, and Benefits of Cloud Computing - Cloud Deployment Models: Public, Private, Hybrid Clouds - Cloud Service Models: IaaS, PaaS, SaaS - Virtualization Concepts and Technologies - Cloud Providers Overview (AWS, Azure, Google Cloud) - Business Agility and Cloud Economics

UNIT II CLOUD VIRTUALIZATION AND INFRASTRUCTURE 9 hours

Virtual Machines, Containers, and Docker - Hypervisors - Type 1 and Type 2 - Network Virtualization and Software Defined Networking (SDN) - Storage Virtualization and Cloud Storage Architectures - Data Center Design and Resource Management - Scalability and Load Balancing in the Cloud.

UNIT III CLOUD STORAGE AND SECURITY 9 hours

Cloud Storage Models: Block, File, and Object Storage - NoSQL Databases and Big Data Technologies - Cloud Data Management and Backup Strategies - Cloud Security Fundamentals: Identity and Access Management (IAM) - Encryption, Compliance, and Shared Security Responsibility Model - Cloud Security Challenges and Solutions

UNIT IV CLOUD APPLICATION DEVELOPMENT 9 hours

Cloud Native Applications and Microservices Architecture - Container Orchestration with Kubernetes - Serverless Computing and Functions as a Service (FaaS) - Cloud APIs and SDKs - DevOps and Continuous Integration/Continuous Delivery (CI/CD) in Cloud - Case Studies of Enterprise Cloud Applications

UNIT V ENTERPRISE CLOUD STRATEGY AND MANAGEMENT 9 hours

Cloud Strategy Planning and Governance - Cost Management and Cloud Billing Models - Performance Monitoring and SLA Management - Disaster Recovery and Business Continuity in Cloud - Cloud Migration Approaches and Tools - Emerging Trends in Enterprise Cloud Computing

Course Outcomes:

After completing this Unit, students will be able to

CO1: Explain core concepts and services of enterprise cloud computing.
CO2: Implement cloud virtualization and manage cloud infrastructure.
CO3: Design secure cloud storage and data management solutions.
CO4: Develop and deploy cloud-native applications using contemporary tools.
CO5: Formulate and manage cloud strategies aligned with enterprise goals.

Text Book(s)

1. Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011.
2. Kai Hwang, Jack Dongarra, and Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann, 2013.
3. Boris Scholl, Trent Swanson, and Peter Jausovec, Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, O'Reilly, 2020.

Reference Books

1. Barrie Sosinsky, Cloud Computing Bible, Wiley, 2011.
2. Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Pearson, 2013.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – II

25MBCSEDC04 BIG DATA ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

This course provides a study of big data frameworks used for large-scale data storage and processing. It covers the architecture, components, and applications of frameworks such as Hadoop, Spark, Flink, and Storm. Students will gain knowledge in configuring and managing clusters, processing batch and streaming data, and designing scalable, fault-tolerant big data solutions for real-world applications.

Course Objectives:

This course enables students to

1. To understand the Big Data Platform and its Use cases.
2. To provide an overview of Apache Hadoop Ecosystem.
3. To provide HDFS Concepts and Interfacing with HDFS.
4. To understand Map Reduce concepts.
5. To understand different mining streams

UNIT I INTRODUCTION TO BIG DATA AND HADOOP 9 hours

Introduction to Big Data and Hadoop: Types of Digital Data – Introduction to Big Data – Big Data Analytics – History of Hadoop – Analysing Data with Hadoop – Hadoop Streaming – Hadoop Eco System – Applications of Big Data: marketing – fraud detection – risk assessment – credit risk management – healthcare – medicine – advertising.

UNIT II HDFS (HADOOP DISTRIBUTED FILE SYSTEM) 9 hours

HDFS (Hadoop Distributed File System): Design of HDFS – HDFS Concepts – Command Line Interface – Hadoop file system interfaces – Data flow – Data Ingest with Flume and Sqoop – Hadoop I/O: Compression – Serialization – Avro and File-Based Data structures.

UNIT III MAP REDUCE 9 hours

Map Reduce: Anatomy of a Map Reduce - Job Run – Failures – Job Scheduling – Shuffle and Sort – Task Execution – Map Reduce Types and Formats – Map Reduce Features - Composing map reduce calculations.

UNIT IV HADOOP ECOSYSTEM 9 hours

Hadoop Ecosystem: Introduction to PIG – Execution Modes of Pig – Comparison of Pig with Databases – Grunt – Pig Latin – User Defined Functions – Data Processing operators - Hbase – data model and implementations – Hbase clients – Hbase examples – Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

UNIT V MINING DATA STREAMS 9 hours

Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Describe big data and use cases from selected business domains
CO2: List the components of Hadoop and Hadoop Eco-System
CO3: Access and Process Data on Distributed File System
CO4: Manage Job Execution in Hadoop Environment
CO5. Apply and analyze techniques for processing data streams

Text Book(s)

1. Tom White — Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, 2015.
2. Bill Chambers and Matei Zaharia — Spark: The Definitive Guide, O'Reilly Media, 2018.
3. Rajkumar Buyya, Rodrigo N. Calheiros, and Amir Vahid Dastjerdi — Big Data: Principles and Paradigms, Morgan Kaufmann, 2016.

Reference Books

1. Tyler Akidau, Slava Chernyak, and Reuven Lax — Streaming Systems: The What, Where, When, and How of Large-Scale Data Processing, O'Reilly Media, 2018
2. Jules S. Damji, Brooke Wenig, Tathagata Das, and Denny Lee — Learning Spark: Lightning-Fast Data Analytics, 2nd Edition, O'Reilly Media, 2020..

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – II

25MBCSEDC05 BLOCKCHAIN TECHNOLOGY

L	T	P	C
3	0	0	3

Pre-requisite :

Course Description:

A blockchain is a decentralized, distributed, and public digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the consensus of the network.

This course provides a broad overview of the essential concepts of blockchain technology and by initially exploring the Bitcoin protocol followed by the Ethereum protocol. It familiarizes with the functional/operational aspects of cryptocurrency eco-system.

Course Objectives:

This course enables students to

1. understand the importance of fundamentals of blockchain technology
2. acquire knowledge about cryptography and algorithms.
3. understand the knowledge in the concepts of bitcoin and consensus algorithms.
4. implement decentralized blockchain-based software Ethereum
5. examine the needed frameworks, standards, tools and libraries to build blockchains and related applications using Hyper ledger.

UNIT I INTRODUCTION TO BLOCKCHAIN 9 hours

Introduction to Blockchain Technology - The growth of blockchain technology - Distributed systems - The history of blockchain - Benefits and limitations of blockchain - Types of blockchain - Consensus - CAP theorem and blockchain - Decentralization using blockchain - Methods of decentralization - Routes to decentralization - Platforms for decentralization

UNIT II CRYPTOGRAPHY IN BLOCKCHAIN 9 hours

Cryptography in Blockchain: Introduction - Cryptographic primitives - Symmetric Cryptography - Data Encryption Standard (DES) - Advanced Encryption Standard - Asymmetric Cryptography - public and private keys - RSA - Secure Hash Algorithms.

UNIT III INTRODUCTION TO BITCON 9 hours

BitCoin - Introduction – Transactions - Structure - Transactions types – Blockchain - Wallets and its types - Bitcoin payments - Bitcoin improvement proposals (BIPs) - Bitcoin investment and buying and selling bitcoins - Bitcoin installation - Bitcoin limitations - Consensus Algorithms - Smart Contract - History of Smart Contract - Ricardian contracts

UNIT IV ETHEREUM 9 hours

Ethereum - The yellow paper - The Ethereum network - Ethereum block chain - Components of the Ethereum block chain - Accounts and its types - The Ethereum Virtual Machine - Blocks and blockchain - Mining Wallets - Applications developed on Ethereum - Scalability and security issues - Blockchain usecases in Banking & Financial Service

UNIT V HYPERLEDGER **9 hours**

Hyperledger as a protocol - The reference architecture - Fabric - Hyperledger Fabric - Distributed Ledger - Sawtooth lake - Corda - Hyperledger projects.

Course Outcomes:

After completing this Unit, students will be able

CO1: To understand the fundamentals of blockchain technology.
CO2: To obtain knowledge on analysing various cryptographic algorithms.
CO3: To implement Bitcoin to develop solutions in the appropriate domains.
CO4: To device a decentralized blockchain-based software Ethereum
CO5: To apply Hyperledger Fabric to implement the Block chain Application.

Text Book(s)

1. Imran Bashir, Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained, 2nd Edition, 2nd Revised edition edition. Birmingham: Packt Publishing, 2018.

Reference Books

1. Andreas M. Antonopoulos, Mastering bitcoin, First edition. O'Reilly,2015.

2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder "Bitcoin and Cryptocurrency Technologies a Comprehensive Introduction", Princeton University Press.

3. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

4. Merunas Grincalaitis, "Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols" Packt Publishing.

5. Prof. Sandip Chakraborty, Dr. Praveen Jayachandran, "Blockchain Architecture Design and Use Cases" [MOOC], NPTEL: https://nptel.ac.in/courses/106/105/106105184

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – II

25MBCSEDC06 DevOps

L	T	P	C
3	0	0	3

Pre-requisite Nil

Course Description:

This course introduces the concepts, tools, and practices of DevOps, focusing on integrating software development and IT operations. It covers the DevOps lifecycle, automation, containerization, CI/CD, monitoring, and security, with emphasis on understanding principles and workflows through popular tools like Git, Jenkins, Docker, Kubernetes, Ansible, and Prometheus.

Course Objectives:

This course enables students to

1. Explain the principles, culture, and benefits of DevOps along with its lifecycle stages.
2. Apply version control techniques and continuous integration concepts using tools like Git and Jenkins.
3. Describe containerization technologies such as Docker and fundamentals of configuration management tools.
4. Implement deployment strategies and application orchestration using Kubernetes and Helm.
5. Analyse monitoring, logging tools, and security integration approaches in DevOps pipelines.

UNIT I INTRODUCTION TO DEVOPS 9 hours

Software development models: Waterfall, Agile, DevOps - DevOps principles, culture, and benefits - DevOps lifecycle stages: Development, Testing, Integration, Deployment, Monitoring - Overview of DevOps tools landscape (Git, Jenkins, Docker, Kubernetes, Ansible, Prometheus) - Case studies of DevOps adoption.

UNIT II VERSION CONTROL AND CONTINUOUS INTEGRATION 9 hours

Version Control Systems: Centralized vs Distributed - Git basics: repository, commit, branch, merge, pull/push - Git workflows and collaboration - Continuous Integration concepts - Jenkins basics and pipeline overview - Introduction to build tools: Maven, Gradle.

UNIT III CONTAINERIZATION AND CONFIGURATION MANAGEMENT 9 hours

Virtualization vs Containerization - Docker architecture and components - Images, containers, and Docker file basics - Docker Compose overview - Configuration Management fundamentals - Introduction to Ansible, Puppet, Chef concepts.

UNIT IV CONTINUOUS DELIVERY, DEPLOYMENT, AND ORCHESTRATION 9 hours

Continuous Delivery vs Continuous Deployment - Deployment strategies: Rolling updates, Blue-Green deployment - Kubernetes architecture and key components (pods, services, deployments) - Application deployment workflows in Kubernetes - Introduction to Helm for Kubernetes package management.

UNIT V MONITORING, LOGGING, AND SECURITY 9 hours

Role of monitoring in DevOps - Overview of monitoring tools: Prometheus, Grafana - Logging basics: ELK (Elasticsearch, Logstash, Kibana) stack - Code quality tools: SonarQube overview - Introduction to DevSecOps concepts - Overview of cloud-based DevOps tools (AWS, Azure, GCP).

Course Outcomes:

After completing this Unit, students will be able to
CO1: Explain the DevOps lifecycle and its role in agile software development.
CO2: Describe version control and continuous integration concepts for software builds.
CO3: Understand containerization and orchestration approaches used in software deployment.
CO4: Explain configuration management and its benefits in DevOps workflows.
CO5: Describe monitoring, logging, and security integration in DevOps pipelines.

Text Book(s)

1. Len Bass, Ingo Weber, Liming Zhu – DevOps: A Software Architect's Perspective, Addison-Wesley, 2015.
2. Gene Kim, Jez Humble, Patrick Debois, John Willis – The DevOps Handbook, IT Revolution Press, 2016.

Reference Books

1. Jez Humble, David Farley – Continuous Delivery, Addison-Wesley, 2010.
2. Kief Morris – Infrastructure as Code, O'Reilly, 2016.
3. Nigel Poulton – Docker Deep Dive, Independently Published, 2020.
4. Brendan Burns – Kubernetes: Up and Running, O'Reilly, 2022.
5. Nicole Forsgren, Jez Humble, Gene Kim – Accelerate: The Science of Lean Software and DevOps, IT Revolution Press, 2018.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – III

25MBCSEDC07 SOFT COMPUTING TECHNIQUES

L	T	P	C
3	0	0	3

Pre-requisite NIL

Course Description:

This course introduces the principles and applications of soft computing paradigms, including artificial neural networks, fuzzy systems, and evolutionary/nature-inspired algorithms. Students will learn the theoretical foundations, architectures, and computational models that enable approximate reasoning, learning, and adaptation for solving complex real-world problems.

Course Objectives:

By the end of this course, students will:

1. Understand the fundamental concepts and scope of soft computing in contrast to hard computing.
2. Gain knowledge of neural network architectures, learning algorithms, and activation functions for various applications.
3. Learn the principles of fuzzy logic, fuzzy set theory, and fuzzy inference systems for decision-making and control.
4. Explore evolutionary and nature-inspired optimization techniques, including genetic algorithms, PSO, and ACO.
5. Develop the ability to apply soft computing techniques to real-world problems using practical examples and case studies.

UNIT I INTRODUCTION TO SOFT COMPUTING 7 hours

What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing.

UNIT II NEURAL NETWORKS 10 hours

What is Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Backpropagation(BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

UNIT III FUZZY SYSTEMS 9 hours

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

UNIT IV EVOLUTIONARY AND NATURE-INSPIRED ALGORITHMS 10 hours

Genetic Algorithms: Representation, Fitness Functions, Selection, Crossover, Mutation, Generational Cycle, Applications of GA in Optimization and Machine Learning, Particle Swarm Optimization (PSO) – Concepts, Update Equations, Variants, Ant Colony Optimization (ACO) – Pheromone Update, Path Construction, Overview of Other Nature-Inspired Algorithms: Differential Evolution, Bacterial Foraging Optimization, Firefly Algorithm, Comparative Study of Optimization Techniques in Soft Computing

UNIT V APPLICATIONS OF SOFTCOMPUTING 9 hours

Genetic Algorithm Application- Bagley and Adaptive Game-Playing Program- Greg Viols Fuzzy Cruise Controller-Air Conditioner Controller-Application of Back Propagation Neural Network.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Differentiate between hard and soft computing paradigms and identify application domains for soft computing.

CO2: Design and implement artificial neural network models using appropriate learning rules and architectures.

CO3: Apply fuzzy logic concepts to model uncertainty and develop fuzzy-based decision-making and control systems.

CO4: Utilize evolutionary and swarm intelligence algorithms for optimization in engineering and research problems.

CO5: Integrate and apply soft computing techniques in practical applications such as intelligent control systems and adaptive decision-making.

Text Book(s)

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.

2. S.N. Sivanandam& S.N. Deepa, "Principles of Soft Computing", 3rded, Wiley Publications, 2018.

3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rded, John Wiley and Sons, 2011.

Reference Books

1. Laurene Fausett, Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Pearson Education India, 2006.

2. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.

3. D. K. Pratihar, Soft Computing : Fundamentals and Applications (2nd Ed.) (Narosa, 2013)

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – III

25MBCSEDC08 QUANTUM COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

Quantum Computing introduces the principles of quantum mechanics and their application to computation, exploring concepts like qubits, superposition, entanglement, and quantum algorithms. Quantum Computing often involve hands-on experience with quantum programming using tools like Qiskit and may cover quantum error correction and applications in various fields.

Course Objectives:

This course enables students to

1. To know the background of classical computing and quantum computing.
2. To learn the fundamental concepts behind quantum computation.
3. To study the details of quantum mechanics and the relation to Computer Science.
4. To gain knowledge about the basic hardware and mathematical models of quantum computation.
5. To learn the basics of quantum information and the theory behind it.

UNIT I INTRODUCTION TO QUANTUM COMPUTING 9 hours

Global Perspectives – Quantum Bits – Quantum Computation – Quantum Algorithms – Experimental Quantum Information Processing – Quantum Information.

UNIT II QUANTUM MECHANICS AND OVERVIEW OF COMPUTATIONAL MODEL 9 hours

Quantum Mechanics: Linear Algebra – Postulates of Quantum Mechanics – Application: Superdense Coding – Density Operator – The Shmidt Decomposition and Purifications – EPR and the Bell Inequality – Computational Models: Turing Machines – Circuits – Analysis of Computational Problems.

UNIT III QUANTUM COMPUTATION 9 hours

Quantum Circuits: Quantum Algorithms – Universal Quantum Gates – Quantum Circuit Model of Computation – Simulation – Quantum Fourier Transform and Applications – Quantum Search Algorithms – Quantum Computers.

UNIT IV QUANTUM INFORMATION 9 hours

Quantum Noise and Quantum Operations: Classical Noise and Markov processes – Quantum Operations – Examples – Applications – Distance Measures for Quantum Information – Quantum Error Correction – Entropy.

UNIT V QUANTUM INFORMATION THEORY 9 hours

Quantum States and Accessible Information – Data Compression – Classical Information Over Noisy Quantum Channels – Quantum Information Over Noisy Quantum Channels – Entanglement as a Physical Resource – Quantum Cryptography.

Course Outcomes:
After completing this Unit, students will be able to
CO1: Understand the basics of quantum computing.
CO2: Understand the background of Quantum Mechanics.
CO3: Analyse the computation models.
CO4: Understand the quantum operations such as noise and error–correction.
CO5: Appreciate the need of quantum computing.

Text Book

1. Michael A. Nielsen, Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010.

Reference Book

1. Scott Aaronson, "Quantum Computing Since Democritus", Cambridge University Press, 2013.

2. N. David Mermin, "Quantum Computer Science: An Introduction", Cambridge University Press, 2007.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – III

25MBCSEDC09 CYBER SECURITY

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:

The course is designed to provide awareness on different cybercrimes, cyber offenses, tools and methods used in cybercrime.

Course Objectives:

This course enables students to

1. Provide foundational knowledge of cybercrime, its classifications, and legal perspectives with a focus on the Indian IT Act 2000 and global frameworks
2. Understand the methods and strategies used by cybercriminals to plan and execute cyber offenses, including social engineering and emerging attack vectors.
3. Analyse the security challenges posed by mobile and wireless technologies.
4. Explore the various tools, techniques, and malicious software used in cybercrimes.
5. Examine the impact of cyber threats on organizations and understand strategies for mitigating security and privacy risks in a digital environment.

UNIT I INTRODUCTION TO CYBERCRIME 9 hours

Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, And Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

UNIT II CYBER OFFENSES: HOW CRIMINALS PLAN THEM 9 hours

Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber Cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing

UNIT III CYBERCRIME: MOBILE AND WIRELESS DEVICES 9 hours

Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones,

MobileDevices:

Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT IV TOOLS AND METHODS USED IN CYBERCRIME 9 hours

Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

UNIT V CYBER SECURITY: ORGANIZATIONAL IMPLICATIONS 9 hours

Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

Course Outcomes:

After completion of the course, students will be able to

CO1: Classify the cybercrimes and understand the Indian ITA 2000.
CO2: Analyse the vulnerabilities in any computing system and find the solutions.
CO3: Predict the security threats of the future.
CO4: Investigate the protection mechanisms.
CO5: Design security solutions for organizations.

Text Book(s)

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA.

Reference Books

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan- Hwa(john) Wu, J. David Irwin, CRC Press T&F Group

Online Learning Resources:

http://nptel.ac.in/courses/106105031/40
http://nptel.ac.in/courses/106105031/39
http://nptel.ac.in/courses/106105031/38

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – IV

25MBCSEDC10 RESPONSIBLE AI

L	T	P	C
3	0	0	3

Pre-requisite

Course Description:
This course provides an in-depth exploration of Responsible Artificial Intelligence (AI), focusing on the ethical, legal, and social implications of AI technologies in contemporary society. Students will learn how AI systems can unintentionally reinforce bias, compromise privacy, and challenge accountability, while also exploring strategies to ensure fairness, transparency, and trustworthiness.

Course Objectives:
This course enables students to

1. To understand the ethical foundations and need for Responsible AI.
2. To identify and mitigate bias in data, algorithms, and AI systems.
3. To apply interpretability and explainability methods for AI models.
4. To examine privacy, accountability, and security challenges in AI.
5. To critically evaluate Indian and global case studies of Responsible AI applications.

UNIT I INTRODUCTION TO RESPONSIBLE AI 9 hours

Overview of Artificial Intelligence and Applications, Ethical foundations: Ethical Theories, Values, Ethics in Practice, Implementing Ethical Reasoning.

UNIT II FAIRNESS AND BIAS IN AI 9 hours

Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, in-processing and postprocessing to remove bias, Group fairness and Individual fairness, Counterfactual fairness.

UNIT III INTERPRETABILITY AND EXPLAINABILITY 9 hours

Simplification and Visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation.

UNIT IV ACCOUNTABILITY, PRIVACY, AND SECURITY 9 hours

Auditing AI models, Fairness assessment, Principles for ethical practices, Attack models, Privacy-preserving Learning, Differential privacy, Federated learning, Emerging Indian AI regulations and ethical frameworks.

UNIT V FRAMEWORKS AND CASE STUDIES 9 hours

AI for social good, Responsible AI frameworks and toolkits, Role of engineers in shaping responsible AI, Emerging trends: Generative AI, autonomous systems, human–AI collaboration.
Case Studies: Facial Recognition & Generative AI – Ethical challenges in surveillance and risks of misinformation in education and media. Aarogya Setu App – Balancing public health and privacy in India's COVID-19 response.

Course Outcomes:
After completing this Unit, students will be able to
CO1: Explain the ethical theories, values, and principles relevant to AI.
CO2: Analyze sources of bias and apply methods for fairness in AI.
CO3: Demonstrate interpretability and explainability techniques for AI models.
CO4: Evaluate accountability, security, and privacy-preserving mechanisms in AI.
CO5: Assess real-world AI applications through case studies and frameworks.

Text Book(s)

1. Virginia Dignum, Responsible Artificial Intelligence: Developing and Using AI in a Responsible Way, Springer, 2019.
2. NITI Aayog, National Strategy for Artificial Intelligence – #AIforAll, Government of India, 2018.

Reference Books

1. Mark Coeckelbergh, *AI Ethics*, MIT Press, 2020.
2. Christoph Molnar "Interpretable Machine Learning".Lulu, 1st edition, March 24, 2019; eBook. ISBN-10 : 0244768528, ISBN-13 : 978-0244768522

Mode of Evaluation: Assignments, Mid Term Tests, Semester End Examination.

Discipline Elective - IV

25MBCSEDC11 INTERNET OF THINGS

L	T	P	C
3	0	0	3

Pre-requisite Nil

Course Description:

This course explores Industry 5.0, focusing on human-centric, sustainable, and resilient industrial systems that integrate advanced technologies like AI, IoT, and collaborative robots. It covers enabling technologies, human-machine collaboration, and sustainability frameworks with real-world case studies.

Course Objectives:

This course enables students to

1. To introduce the evolution from Industry 4.0 to Industry 5.0.
2. To explore human-centric automation, collaborative robotics, and ethical AI.
3. To understand the role of emerging technologies like IoT, AI, Edge Computing, Digital Twins.
4. To develop smart and sustainable solutions aligned with Industry 5.0 goals.
5. To Evaluate real-world applications of Industry 5.0 across sectors through case studies

UNIT I FUNDAMENTALS AND OVERVIEW OF IOT 9 hours

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF), Simplified IoT Architecture and Core IoT Functional Stack – Fog orchestration and Data Management, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, RFID, Video Tracking Applications and Algorithms, Actuators, Smart Objects and Connecting Smart Objects.

UNIT II IOT PROTOCOLS, SECURITY, AND PRIVACY 9 hours

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 1901.2a, LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, SCADA, Application Layer Protocols: CoAP and MQTT, Security and Privacy in IoT: Concepts and Overview, Security Frameworks, Privacy in IoT Network: Fog and Cloud Domain Attacks, Sensing Domain Attacks and their Countermeasures.

UNIT III DESIGN AND DEVELOPMENT 9 hours

Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi, Arduino, and PyBoard with Python Programming, IoT Backend design with Python – Flask and Microsoft Azure implementation.

UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES 9 hours

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework

– Django – AWS for IoT – System Management with NETCONF-YANG, Use of Big Data in Visualization of IoT, Industry 4.0 concepts.

UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS 9 hours

Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control, Cloud of Things: Standards and Architecture, Open-Source E-Health Sensor Platform, Cloud-assisted Cyber-Physical Systems. Introduction to Blockchain in IoT.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Explain the concept of IoT
CO2: Analyze various protocols, security and privacy for IoT
CO3: Design a PoC of an IoT system using Raspberry Pi, Arduino, and PyBoard
CO4: Apply data analytics and use cloud offerings related to cloud
CO5: Analyse applications of IoT in a real time scenario.

Text Book(s)

1. Ammar Rayes, Hafedh Yahmadi, Nabil sahil, Samer Salam ―Internet of Things from Hype The Road to Digitization, Springer, 2019
2. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach, Universities Press, 2015.

Reference Books

1. Rajkumar Buyya, Amir Vahid Dastjerdi -Internet of Things Principles and Paradigms, Morgan ,2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012
3. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things– Introduction to a New Age of Intelligence", Elsevier, 2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
5. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
6. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

Discipline Elective – IV

25MBCSEDC12 PENETRATION TESTING

L	T	P	C
3	0	0	3

Pre-requisite Computer Networks and Cybersecurity Fundamentals

Course Description:

This course introduces the principles, methodologies, and tools used in penetration testing to assess the security of systems and networks. Students will learn to identify vulnerabilities, exploit weaknesses ethically, and recommend mitigation strategies, aligning with industry practices and legal frameworks.

Course Objectives:

This course enables students to

1. Understand the principles, methodologies, and ethical considerations of penetration testing.
2. Describe various information gathering techniques used during penetration testing.
3. Analyse common vulnerabilities in systems and networks through vulnerability assessment.
4. Demonstrate the use of Metasploit exploitation tool for penetration testing.
5. Interpret web application security vulnerabilities and testing tools.

UNIT I INTRODUCTION TO PENETRATION TESTING 9 hours

Introduction – Penetration testing overview - Why Penetration testing is needed? – Types and scope of penetration testing - Announced vs. unannounced testing - Strategies for security testing - Phases of penetration testing - Legal and ethical considerations - Rules of engagement (ROE) and NDA agreements - Overview of penetration testing standards (PTES, OSSTMM).

UNIT II INFORMATION GATHERING 9 hours

Information Gathering Techniques - Active, Passive and Sources of Information Gathering - Approaches and Tools - Traceroutes, Neotrace, Whatweb, Netcraft, Xcode Exploit Scanner and NSlookup. Host discovery - Scanning for open ports and services - Types of Port - Service version detection and OS fingerprinting – Evasion techniques during scanning.

UNIT III VULNERABILITY ANALYSIS 9 hours

Vulnerability Scanner Function, pros and cons - Vulnerability Assessment with NMAP - Testing SCADA environment with NMAP - Nessus Vulnerability Scanner - Overview of Top Web Application Security Vulnerabilities, Injection Vulnerabilities, Cross-Site Scripting Vulnerabilities

UNIT IV EXPLOITS 9 hours

Metasploit on Penetration Tests, Understanding - Metasploit Channels, Metasploit Framework and Advanced Environment configurations - Metasploit architecture and module structure, Configuration and Locking, Advanced payloads and addon modules Global datastore, module datastore, saved environment Meterpreter.

UNIT V WEB APPLICATION PENETRATION TESTING 9 hours

Testing for common web vulnerabilities: SQLi, XSS, CSRF, file inclusion - Authentication and session testing - Web application testing tools: Burp Suite, OWASP ZAP.

Course Outcomes:

After completing this Unit, students will be able to

CO1: Explain the role and importance of penetration testing in cybersecurity.
CO2: Identify and perform different information gathering methods effectively.
CO3: Evaluate system vulnerabilities and assess associated risks.
CO4: Utilize Metasploit framework for exploiting vulnerabilities ethically.
CO5: Assess security weaknesses in web applications and apply relevant testing strategies.

Text Book(s)

1. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking, No Starch Press, 2014.
2. Andrew Whitaker and Daniel P. Newman, Penetration Testing and Network Defence The practical guide to simulating, detecting and responding to network attacks, Cisco Press, 2010. ISBN: 1-58705-208-3.

Reference Books

1. Abhinav Singh, Metasploit Penetration Testing Cookbook, PACKT Publishing, 2012. ISBN 978-1-84951-742-3
2. The Pen Tester Blueprint - Starting a Career as an Ethical Hacker, L. Wylie, Kim Crawly,1st Edition, Wiley Publications.
3. John Slavio. Hacking: A Beginners' Guide to Computer Hacking, Basic Security, And Penetration Testing.

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.