Semester- III

Data Mining and Visualization			
Course Code	**MMCA311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand foundational concepts of data mining, including data preprocessing, pattern discovery, and classification techniques.
- Apply data mining algorithms to extract useful patterns, trends, and insights from large datasets.
- Analyse and interpret mined data using appropriate visualization techniques and tools.
- Develop skills to evaluate the performance of various data mining models and choose suitable techniques based on problem context.
- Use data visualization tools and libraries to present complex data and mining results in an intuitive and meaningful way.

Module-1

Foundations of Data Mining and Data Preprocessing

Introduction to Data Mining & Preprocessing Techniques: Introduction to data mining: Motivation, architecture, KDD process. Types of data: Structured, semi-structured, unstructured.
Data preprocessing: Cleaning, integration, reduction, transformation, Missing Values and Noisy Data. Data summarization and visualization techniques for preprocessing analysis. Implementation using Python: Pandas, NumPy for basic preprocessing.

Module-2

Data Mining Techniques and Algorithms

Mining Techniques: Classification, Clustering & Association: Classification: Decision Trees, k-NN, Naive Bayes – concepts and implementation. Clustering: k-Means, Hierarchical clustering.
Association rule mining: Market basket analysis, Apriori algorithm, FP-Growth. Evaluation methods: Confusion matrix, precision, recall, ROC.

Module-3

Data Visualization Techniques

Static and Interactive Data Visualization with Python: Principles of effective data visualization. Visualization tools and libraries: Matplotlib, Seaborn, Plotly, Bokeh. Histograms, bar charts, scatter plots, heatmaps, and pair plots.
Dashboard creation using Jupyter notebooks and interactive widgets. Case studies and real-world examples using multi-dimensional data.

Module-4

Visualizing Streaming and Real-Time Data

Real-Time Analytics and Streaming Data Visualization Overview of streaming data: Sources, characteristics, and tools. Real-time processing with Apache Kafka, PySpark Streaming (introductory overview).
Visualization strategies for streaming data. Tools: Dash by Plotly, Streamlit, Grafana.
Case studies: Sensor data, web server logs.

Module-5

Advanced Data Mining Applications and Trends

Emerging Trends and Applications in Data Mining social media and text data. Sentiment analysis and NLP basics using Python. Time series analysis and visualization. Anomaly detection and predictive analytics. Ethical issues and future trends in data mining.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Jiawei Han, Micheline Kamber, Jian Pei**, *Data Mining Concepts and Techniques*, Morgan Kaufmann.
2. **Wes McKinney**, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Python*, O'Reilly Media.
3. **Tim Grobmann, Mario Dobler**, *Data Visualization with Python*, O'Reilly Media.

Web links and Video Lectures (e-Resources):

- **NPTEL – Data Mining by IIT Kharagpur** (Prof. Pabitra Mitra)
  https://nptel.ac.in/courses/106105174
- **Data Mining Full Course by Great Learning** (YouTube)
  https://www.youtube.com/watch?v=RlD5q_pIWkM
- **Data Visualization using Python (Edureka)**
  https://www.youtube.com/watch?v=UB3DE5Bgfx4
- **Harvard Data Science: Visualization (edX)**
  https://cs50.harvard.edu/
- **Tableau for Data Visualization (Simplilearn)**
  https://www.youtube.com/watch?v=IFM03Nis2dg

Skill Development Activities Suggested

- **Hands-on Data Mining Projects**
- Work on **real-world datasets** (e.g., Kaggle, UCI ML Repository).
- Implement **data preprocessing, cleaning, and feature engineering**.
- Apply **classification, clustering, and association rule mining** techniques.
- **Learning and Using Data Visualization Tools**
- Get hands-on with **Tableau, Power BI, and Matplotlib/Seaborn in Python**.
- Use **SQL for data extraction and processing**.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand foundational concepts of data mining and apply preprocessing techniques using Python.	L2
CO2	Implement key data mining techniques such as classification, clustering, and association rule mining.	L3
CO3	Design and develop effective static and interactive data visualizations using Python libraries.	L3
CO4	Apply real-time visualization strategies for streaming data using tools like Dash, Streamlit, and Grafana.	L3
CO5	Analyse advanced data mining applications including sentiment analysis, time series, and anomaly detection.	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1					
CO2	3	3	2	2				
CO3	2	2	3	2	1			
CO4	2	3	3	3	2			
CO5	3	2	3	3	2	1		

Semester- III

Big Data Analytics			
Course Code	**MMCA311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand Big Data Concepts – Gain a comprehensive understanding of Big Data, its characteristics, and its significance in modern computing.
- Explore Big Data Technologies – Learn about various Big Data tools and frameworks such as Hadoop, Spark, and NoSQL databases.
- Perform Data Processing & Analysis – Develop skills in processing, storing, and analysing large-scale data using distributed computing techniques.

Module-1

Big Data Fundamentals and Ecosystem Overview

Introduction to Big Data: Concepts and Ecosystem: Definition and Evolution of Big Data. Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value). Traditional vs Big Data Systems,
Introduction to Hadoop Ecosystem: HDFS, YARN, MapReduce. Architecture and components of Hadoop. Limitations of Hadoop and the shift to Spark

Module-2

Hadoop Architecture and MapReduce Programming

Distributed Data Processing using Hadoop: Hadoop Distributed File System (HDFS): Design and operations. Hadoop MapReduce: Programming model, job execution flow. Writing MapReduce programs (Word Count, Sorting, Joins). Advanced Hadoop: Combiners, Partitioners, Counters. Hadoop Streaming and integration with Python.

Module-3

Apache Spark for Big Data Analytics

In-Memory Big Data Processing with Spark: Spark architecture and components: RDDs, DAG, Executors. Transformations and Actions on RDDs. Introduction to Data Frames and Spark SQL.
Introduction to Spark MLlib for machine learning. PySpark: Setting up and running Spark jobs using Python.

Module-4

NoSQL and Big Data Storage Systems

Scalable Data Storage with NoSQL Databases: Need for NoSQL: Limitations of RDBMS in Big Data. Types of NoSQL Databases: Key-Value, Document, Column, Graph. Introduction to HBase: Architecture and CRUD operations. Working with Cassandra and MongoDB. Data modelling for scalability and performance.

Module-5

Big Data Tools and Industry Applications

Real-World Big Data Applications and Tools: Overview of Big Data Tools: Hive, Pig, Sqoop, Flume, Oozie. Data ingestion with Flume and Sqoop. Use cases in healthcare, finance, e-commerce, IoT, social media. Real-time analytics introduction using Kafka and Spark Streaming. Ethics and challenges in Big Data (privacy, bias, governance).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. . **Tom White** – *Hadoop: The Definitive Guide*, O'Reilly Media.
2. **Vignesh Prajapati** – *Big Data Analytics with R and Hadoop*, Packt Publishing.
3. **Jure Leskovec, Anand Rajaraman, Jeff Ullman** – *Mining of Massive Datasets*, Cambridge University Press.
4. **Venkat Ankam** – *Big Data Analytics with Spark*, Packt Publishing.

Weblinks and Video Lectures (e-Resources):

- **NPTEL Big Data Analytics Course** – https://nptel.ac.in/courses/106/104/106104189/
- **Simplilearn Big Data Tutorial (YouTube)** – https://www.youtube.com/watch?v=-FrXAKGthF8
- Detailed explanation of Big Data concepts and tools.
- **Big Data Analytics Using Python (YouTube - Great Learning)** – https://www.youtube.com/watch?v=ZkZclIFmgVY

Skill Development Activities Suggested

- **Hands-on with Hadoop and Spark** – Work on real-time data processing using Hadoop (HDFS, MapReduce) and Apache Spark. Set up a small Hadoop cluster and practice writing Spark applications.
- **Data Processing and SQL** – Master SQL-based tools like Hive, Impala, and Presto. Work with large datasets to optimize queries and improve performance.
- **Machine Learning with Big Data** – Implement machine learning algorithms using libraries like MLlib (Spark) and TensorFlow with large datasets.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamental concepts, evolution, and architecture of Big Data, including the Hadoop ecosystem.	L1
CO2	Develop and execute distributed data processing tasks using HDFS and MapReduce programming techniques.	L2
CO3	Analyze and implement in-memory data processing using Apache Spark and perform machine learning tasks with Spark MLlib.	L3
CO4	Compare and evaluate NoSQL data models (Key-Value, Document, Column, Graph) and perform operations on HBase, MongoDB, and Cassandra.	L4
CO5	Apply big data tools (Hive, Pig, Sqoop, Flume, Kafka) in real-world domains and understand ethical issues related to Big Data analytics.	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2						
CO2	1	2	3					
CO3		2	3		3			3
CO4		2						3
CO5		2	3	3			3	

Semester- III

Business Data Analytics			
Course Code	**MMCA311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the Fundamentals of Business Analytics – Learn the core concepts, tools, and techniques used in data-driven decision-making for businesses.
- Data Collection and Processing – Gain knowledge of data acquisition, cleaning, transformation, and management techniques for business applications.
- Exploratory Data Analysis & Visualization – Develop skills to analyze and visualize business data using statistical and graphical methods.
- Predictive Analytics & Machine Learning – Apply statistical models and machine learning techniques to predict business trends and customer behavior.

Module-1

Foundations of Business Data Analytics

Introduction to Business Analytics and Data-Driven Decision Making: Introduction to Business Analytics: Scope, Types (Descriptive, Predictive, Prescriptive). Data in Business: Structured vs Unstructured, Sources of Data. Business Intelligence vs Business Analytics.

Analytics Life Cycle: CRISP-DM methodology. Role of Business Analyst: Tools, Skills, and Case Examples

Module-2

Data Preprocessing and Exploratory Analysis

Data Wrangling, Cleaning, and Exploration for Business Insights:

Data Preparation: Cleaning, Integration, Transformation. Handling Missing Data, Outliers, and Noise. Descriptive Statistics: Mean, Median, Mode, Variance, Skewness. Correlation and Covariance.

Visualization for Exploration: Histograms, Boxplots, Heatmaps. Business Case: Customer Segmentation and Sales Data Analysis.

Module-3

Predictive Analytics in Business

Forecasting and Predictive Modelling for Business Decision Making:

Introduction to Regression: Simple & Multiple Linear Regression. Logistic Regression: Applications in classification. Time Series Analysis and Forecasting Techniques. Model Evaluation: RMSE, MAE, Accuracy, Precision, Recall. Business Applications: Sales Forecasting, Customer Churn Prediction.

Module-4

Prescriptive Analytics and Optimization

Optimization and Decision-Making Techniques:

Introduction to Prescriptive Analytics. Linear Programming and Solver in Excel. Optimization Models: Objective functions, Constraints. Sensitivity and Scenario Analysis. Decision Trees and Business Rules. Case Study: Resource Allocation, Pricing Models, Supply Chain Optimization.

Module-5

Data Visualization and Business Intelligence Tools

Storytelling and Visualization for Business Insights

Principles of Data Visualization and Dashboards. BI Tools: Introduction to Power BI, Tableau. Designing Interactive Dashboards. KPI Definition and Visualization. Business Reporting and Data-Driven Story telling. Final Capstone: Complete Business Analytics Solution

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Abdulhamit Subasi**, *Practical Machine Learning for Data Analysis Using Python*, Academic Press.
2. **U. Dinesh Kumar**, *Business Analytics: The Science of Data-Driven Decision Making*, Wiley.
3. **Wes McKinney**, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, O'Reilly.
4. **Wayne Winston**, *Microsoft Excel Data Analysis and Business Modeling*, Microsoft Press.

Weblinks and Video Lectures (e-Resources):

- **Introduction to Business Analytics** – NPTEL Course
- **Harvard Data Science and Business Analytics Lectures** – YouTube Playlist
- **Coursera: Business Analytics by Wharton** – Coursera

Skill Development Activities Suggested

- **Hands-on Experience with Data Tools**
- Practice using **Excel, Power BI, and Tableau** for data visualization.
- Work with **SQL and NoSQL databases** (MySQL, MongoDB).
- Learn **Python and R** for data analysis.
- **Real-world Data Projects**
- Analyse publicly available datasets (Kaggle, UCI Machine Learning Repository).
- Work on **case studies in business analytics** (sales forecasting, customer segmentation).
- Implement **predictive analytics models** using **machine learning**.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the foundational concepts of business analytics, types of analytics, and the data analytics lifecycle.	L1
CO2	Apply data preprocessing techniques and perform exploratory data analysis to extract meaningful business insights.	L2
CO3	Develop and evaluate predictive models using regression and time series forecasting for business decision making.	L3
CO4	Implement prescriptive analytics using optimization techniques to support data-driven decisions in a business context.	L4
CO4	Design interactive dashboards using BI tools and present data-driven stories for effective communication of business insights.	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2						
CO2		2		2	2			
CO3		2	3					3
CO4			3	3				3
CO5								

Semester- III

Enterprise Resource Planning			
Course Code	**MMCA311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand ERP Concepts – Explain the fundamentals of ERP, its evolution, and its significance in modern businesses.
- Analyze ERP Modules – Explore core ERP modules like Finance, HR, Supply Chain, and Customer Relationship Management (CRM).
- ERP Implementation Strategies – Understand the phases of ERP implementation, challenges, and best practices.
- ERP Technologies & Trends – Examine emerging trends in ERP, such as cloud-based solutions, AI integration, and analytics.
- Real-world Applications – Analyse case studies of ERP implementations in various industries to understand its impact on business efficiency.

Module-1

ERP Systems and Business Process Integration

Fundamentals of ERP and Business Process Mapping Evolution of ERP – MRP, MRP II to ERP. Business Functions and Business Processes. Need for Integration and ERP as an Integrator, Benefits, Risks, and Misconceptions of ERP. Overview of Functional Modules: Finance, HR, Production, Sales. Case Example: Business Process before and after ERP

Module-2

ERP Architecture and Technologies

ERP System Architecture and Technological Infrastructure Client/Server Architecture, Service-Oriented Architecture (SOA), Cloud-based ERP vs On-Premise ERP, ERP Platforms and Databases, ERP and Web Integration, Security, Customization, and Interoperability in ERP Systems.
Overview of leading ERP systems: SAP, Oracle, Microsoft Dynamics, Odoo

Module-3

ERP Modules and Functional Features

Core ERP Modules and Organizational Applications Finance and Accounting Module, Manufacturing and Production Planning, Sales and Distribution, Human Resource Management (HRM).
Supply Chain Management (SCM), CRM and Business Intelligence Features, Industry Examples: ERP use in Retail, Healthcare, Logistics.

Module-4

ERP Implementation and Project Management

ERP Life Cycle and Implementation Strategies Phases of ERP Implementation Life Cycle, Business Process Reengineering (BPR) and Change Management, Implementation Methodologies (ASAP, AIM), ERP Project Planning, Testing, Training, Go-Live & Support, Cost-Benefit Analysis, Vendor Selection, Risk Management, Failure Cases and Lessons Learned.

Module-5

Emerging Trends in ERP and Industry Practices

Future Directions and ERP in the Digital Era ERP with AI, ML, IoT, and Blockchain, ERP and Digital Transformation, Mobile ERP and UX Design, ERP in SMEs and Cloud ERPs.
ERP Data Analytics and Reporting, Future Trends: Low-Code ERP, Industry 4.0 Integration, Capstone: Evaluation of ERP for a case enterprise.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Alexis Leon**, *Enterprise Resource Planning*, McGraw Hill Education.
2. **Mary Sumner**, *Enterprise Resource Planning*, Pearson Education.
3. **Mahadeo Jaiswal & Ganesh Vanapalli**, *Enterprise Resource Planning*, Macmillan India.
4. **Ellen Monk, Bret Wagner**, *Concepts in Enterprise Resource Planning*, Cengage Learning.

Weblinks and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=qgHlU_ll6mk
- https://www.youtube.com/watch?v=pSttK5Op1rI&utm_source=chatgpt.com
- https://www.youtube.com/watch?v=JnSrp4k1gJw&utm_source=chatgpt.com
- https://www.youtube.com/watch?v=ppfBvofxCM0&utm_source=chatgpt.com
- https://www.youtube.com/watch?v=cblNqNEThcE&utm_source=chatgpt.com

Skill Development Activities Suggested

- Map business processes of a small business (e.g., order-to-cash or procure-to-pay) using a flowchart or BPMN tool (e.g., Draw.io or Lucidchart).
- Group discussion/debate on ERP benefits vs. risks in real-world businesses.
- Create a basic ERP system architecture diagram using PowerPoint or any diagramming tool.
- Create a module-wise feature matrix comparing SAP, Oracle, and Odoo ERP.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamentals of ERP systems, their evolution, business processes, and the need for integration.	L1
CO2	Analyze ERP architectures, technologies, and distinguish between various deployment models and ERP solutions.	L2
CO3	Examine ERP functional modules and their applications across different business domains.	L3
CO4	Apply ERP implementation strategies, project management techniques, and evaluate risk and success factors.	L4
CO5	Explore and assess emerging trends in ERP such as AI, IoT, Blockchain, and digital transformation practices.	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2						
CO2	1	2			3			
CO3		2	3		3			
CO4			3			3		
CO5					3		3	3

Semester- III

Exploratory Data Analysis			
Course Code	**MMCA311E**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To introduce the fundamental concepts and principles of exploratory data analysis.
- To equip students with skills to summarize and visualize both univariate and multivariate data effectively.
- To develop the ability to clean, pre-process, and transform raw data for analysis.
- To expose learners to current trends and tools used in the field of EDA.

Module-1

Introduction to Exploratory Data Analysis: Historical background and role of EDA in data science, Philosophy and goals of EDA, Comparison with classical statistical methods, Types of data and scales of measurement, Importance of visual summaries before formal modelling.

Module-2

Univariate Data Exploration: Distribution shape: symmetry, skewness, kurtosis Summary statistics: mean, median, mode, variance, standard deviation, range, IQR Graphical techniques: histograms, dot plots, stem-and-leaf plots, boxplots, Identifying outliers and anomalies.

Module-3

Bivariate and Multivariate Data Exploration: Scatter plots, trend analysis, Correlation vs. causation,Crosstabs and pivot tables, Pair plots and heatmaps, Data smoothing (moving averages, LOESS).

Module-4

Data Transformation and Cleaning: Motivation for data transformation (e.g., to achieve normality or reduce skew) Log, square root, and other transformations, Handling missing values and duplicates, Introduction to resistant statistics (median, trimmed mean).

Module-5

Emerging Trends and case studies: EDA as a storytelling tool, AI-powered visualizations, integration with big data platforms.Case studies: EDA on real-world datasets (Titanic, Iris, planet), pitfalls in EDA.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks**
   to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

.1. *Exploratory Data Analysis* by John W. Tukey.

2. *An Introduction to Statistical Learning* by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani

3. *Think Stats: Exploratory Data Analysis in Python* by Allen B. Downey

Reference Books:

1. *Practical Statistics for Data Scientists* by Peter Bruce, Andrew Bruce, and Peter Gedeck

Web links and Video Lectures (e-Resources):

- https://youtu.be/fHFOANOHwh8?si=MFGfiOEvPQSF-g2H
- https://youtu.be/w2QVZHcJapU?si=xfacUu80VK8J4fzc
- https://youtu.be/clblk_NwEU8?si=e4O8qLB6TnuaejdQ

Skill Development Activities Suggested

- Hands-on labs using Python for real-world datasets (Titanic, Iris, Sales, etc.)
- Participation in Kaggle or similar online EDA competitions
- Group project: Collaborative analysis and presentation of EDA findings

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the role and importance of Exploratory Data Analysis in the data science pipeline.	L2
CO2	Analyse univariate and bivariate datasets using appropriate summary statistics and visualization techniques.	L2
CO3	Apply data analysis techniques to explore relationships between multiple variables and derive insights using Python.	L2
CO4	Apply data transformation and cleaning methods to prepare raw data for further analysis.	L2
CO5	Interpret insights from real-world datasets and communicate findings through visual storytelling and reporting.	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2		2						
CO3	1	2			3			
CO4	1			3				3
CO5	1	2						

Semester- III

Social Media Analytics			
Course Code	**MMCA311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the fundamentals and evolution of social media platforms.
- Explore key concepts and techniques in social media data collection and analysis.
- Apply analytics tools to extract insights from social media data.
- Develop skills in sentiment analysis, trend prediction, and influence measurement.
- Design data-driven strategies for business and marketing using social media insights.

Module-1

Introduction to Social Media Analytics

Foundations of Social Media Data Analysis Introduction to Social Media Analytics: Definition, Applications, and Importance, Overview of Popular Social Media Platforms: Facebook, Twitter, Instagram, LinkedIn, YouTube

Social Media Data Types: Structured vs. Unstructured Dat, Social Media Metrics and KPIs: Engagement, Reach, Impressions, Sentiment Score, Data Collection Techniques: Web Scraping, APIs (Twitter, Facebook, YouTube), Streaming Data

Module-2

Sentiment Analysis and Text Mining

Natural Language Processing for Social Media Data Fundamentals of Sentiment Analysis: Positive, Negative, Neutral Sentiments**,** Text Preprocessing: Tokenization, Stopword Removal, Stemming, Lemmatization

Machine Learning Approaches for Sentiment Classification : Naïve Bayes, SVM, LSTM, Word Embeddings and Sentiment Scoring: TF-IDF, Word2Vec, BERT.

Module-3

Social Network Analysis and Trend Detection

Graph-based Social Media Analytics Basics of Social Network Analysis (SNA) Key Metrics: Centrality, Clustering Coefficients, Community Detection, Influencer Identification and User Engagement Analytic

Hashtag Analysis and Topic Modelling using LDA, Trend Detection on Social Media: Time Series Analysis, Virality Prediction.

Module-4

Visualizing and Interpreting Social Media Insights

Data Visualization and Interpretation for Social Media Analytics Importance of Data Visualization in Social Media Analytic.

Visualization Techniques: Word Clouds, Heatmaps, Network Graphs Sentiment Heatmaps and Hashtag Trends Visualization, Dashboard Creation using Tableau and Power BI.

Module-5

Applications of Social Media Analytics in Business and Research

Business and Industry Applications of Social Media Analytics

Social Media Analytics in Digital Marketing: Ad Performance and Customer Engagement, Social Media in Business Intelligence: Brand Monitoring and Crisis Management, Ethical Considerations in Social Media Analytics: Privacy, Bias, and Data Protection.

Future Trends in Social Media Analytics: AI-Driven Social Insights, Capstone Project: Analyzing Real-World Social Media Data for Business Insights.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Matthew A. Russell, Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More, O'Reilly Media.
2. Wasim Ahmed, Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Wiley
3. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining: An Introduction, Cambridge University Press.
4. Piyushimita Thakuriah, Nebiyou Tilahun, Moira Zellner, Seeing Cities Through Big Data: Research, Methods and Applications in Urban Informatics, Springer.

Web links and Video Lectures (e-Resources):

- NPTEL Course on Social Media Analytics – nptel.ac.in
- IBM Social Media Analytics Tutorials – ibm.com
- YouTube Channel: Analytics Vidhya – youtube.com/analyticsvidhya

Skill Development Activities Suggested

- Hands-on training with social media analytics tools (e.g., Hootsuite, Google Analytics).
- Data collection from various social media platforms.
- Analyzing engagement metrics and sentiment.
- Creating visual dashboards and reports.
- Case studies on brand performance and campaign impact.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamentals of social media analytics, data types, key metrics, and data collection techniques.	L2
CO2	Apply sentiment analysis and text mining techniques to analyze social media data using NLP and ML models.	L2
CO3	Analyze social network structures and trends using graph-based analytics, hashtag modeling, and virality detection.	L3
CO4	Visualize and interpret social media insights using tools like Tableau and Power BI to support decision-making.	L4
CO5	Evaluate real-world applications of social media analytics in business, digital marketing, bran monitoring, and ethical considerations.	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**	**2**						
CO2		**2**	**2**		**3**			
CO3		**2**		**3**	**3**			
CO4			**2**		**3**			**3**
CO5					**3**	**3**		

Semester- III

Web Development using Full Stack Open			
Course Code	**MMCB311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the structure and styling of web pages.
- Develop interactive web applications using React.
- Integrate databases for dynamic content.
- Integrate front-end and back-end components.
- Deploy full-stack applications on cloud services.

Module-1

Basics of Web Technologies: Overview of HTML: structure, elements, and semantics, CSS basics: styling, layouts, and responsiveness, avaScript fundamentals: variables, functions, and DOM manipulation, Integrating HTML, CSS, and JavaScript for a basic web page.

Module-2

Front-End Development with React: Introduction to React: Why use React?, JSX and how it differs from HTML, Components: functional vs. class components, Creating dynamic user interfaces with conditional rendering, Handling user events and form submission, React Hooks: useState, useEffect, useContext, and custom hooks, Introduction to Redux: Setting up a Redux store, actions, reducers.

Module-3

Back-End Development with Node.js: Introduction to Node.js: Features and Architecture, Working with npm and package management, Building a basic server using Express, Middleware functions: Logging, authentication, and error handling, Introduction to MongoDB: NoSQL database concepts, CRUD Operations: Creating, reading, updating, and deleting data, Querying and filtering data using Mongoose, Handling database errors.

Module-4

Full-Stack Integration: concept of full-stack applications, RESTful APIs: Principles and best practices, Data exchange using JSON: Serialization and parsing, Connecting React front-end to Node.js back-end, Introduction to authentication and authorization concepts, Implementing user authentication using JWT (JSON Web Token),, Managing user sessions and tokens.

Module-5

Deployment and Maintenance: Setting up Continuous Integration and Continuous Deployment (CI/CD) pipelines, Automating tests and builds using Jenkins, GitHub Actions, or similar tools, Deploying back-end services using AWS EC2, Heroku, and Docker, Deploying back-end services.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Full Stack Open 2023 by University of Helsinki (Online Course Material)
2. Learning React by Alex Banks and Eve Porcello
3. MongoDB: The Definitive Guide by Shannon Bradshaw, Eoin Brazil, and Kristina Chodorow
4. Node.js Design Patterns by Mario Casciaro and Luciano Mammino

Web links and Video Lectures (e-Resources):

- https://youtu.be/Vi9bxu-M-ag?si=OK1-w5YqlKJ5oYh7
- https://youtu.be/nu_pCVPKzTk?si=DOAiec3IorQtKmjA
- https://youtu.be/4EjKroJCpFA?si=gR3jzPn3rgvYwHsl

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamentals of web development using modern technologies.	L1
CO2	Develop full-stack web applications using JavaScript,	L2
CO3	Develop full-stack web applications using React, Node.js	L3
CO4	Develop full-stack web applications using and MongoDB.	L3
CO5	Analyze and solve real-world problems by building scalable web applications.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3							
CO2	3							
CO3							2	
CO4	3	3						
CO5	3	3		3	2	2		

Semester- III

Rich Internet Application Development			
Course Code	**MMCB311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To provide knowledge of rich internet technologies using modern frameworks.
2. To understand and apply client-side scripting, AJAX, and advanced UI/UX.
3. To develop responsive, dynamic, and interactive web applications using frameworks like Angular or React.
4. To learn how to integrate backend services with frontend interfaces.
5. To enable deployment and testing of web applications in real-world environments.

Module-1

Introduction to Rich Internet Applications (RIA) and JavaScript Enhancements: Definition, Evolution, Architecture, RIA vs Traditional Web Applications.Modern JavaScript (ES6+): Let/Const, Arrow functions, Classes, Modules, Promises

Module-2

Client-Side Frameworks and Single Page Applications (SPA): Introduction to SPA – Concepts, Routing, Lifecycle. React.js Basics – Components, Props, State, JSX, Event Handling.

Module-3

AJAX, REST APIs and Asynchronous Communication: AJAX & Fetch API – XMLHttpRequest, Fetch, Axios, Error Handling. Interfacing with REST APIs – JSON, HTTP methods, Postman Testing.

Module-4

Advanced UI Development & State Management: React Advanced – Hooks (useState, useEffect), Context API.UI/UX Libraries – **Material** UI / Bootstrap, Responsive Design Techniques.

Module-5

Deployment, Security and Testing of Web Applications: Deployment – Hosting on Firebase/Vercel, Build & Environment Configuration. Web Application Security & Testing – XSS, CSRF, Linting, Unit Testing with Jest.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- **Learning React:** *Modern Patterns for Developing React Apps*,**Authors:** Alex Banks & Eve Porcello **Publisher:** O'Reilly Media **Edition:** 2nd Edition, 2020
- **Rich Internet Applications with Ajax** Author: **Harwani, B.M.** Publisher: **Dreamtech Press**
- **Modern Full-Stack Development: *Using TypeScript, React, Node.js,* Webpack, *and* Docker** Author: **Frank Zammetti** Publisher: **Apress**

Web links and Video Lectures (e-Resources):

- https://youtu.be/BrjWObZ13AU?si=CUlH3FUfU2F2ujbt
- https://youtu.be/-ZO3QVgs-sk?si=wpOnaHacgL1SxOtF

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the architecture and role of Rich Internet Applications in modern web systems.	L1
CO2	Develop single-page applications using frameworks like React.	L2
CO3	Implement AJAX and RESTful services for interactive client-server communication.	L3
CO4	Design responsive, user-friendly interfaces with advanced UI/UX techniques.	L3,L4
CO5	Secure, test, and deploy scalable rich internet applications on modern platforms.	L4,L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1					
CO2	2		3					
CO3	2		3	2	3			
CO4	1	2	3		3			
CO5	2	2	2	2	3	2		1

Semester- III

Web Development Using PHP and MySQL			
Course Code	**MMCB311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamentals of web technologies.
- Develop dynamic web pages using HTML, CSS, JavaScript.
- Work with MySQL for database-driven applications
- Apply security and validation in web forms.
- Deploy basic web applications.

Module-1

Introduction to Web Technologies: Internet and WWW,Basics of JavaScript and client-side scripting,HTTP, Web Servers, Client-Server Architecture,HTML5 and CSS3 – Forms, Tables, Layout, and Responsive Design.

Module-2

PHP Basics:PHP syntax and variables,Control structures,Functions and Arrays,File Handling, Sessions, and Cookies,Error handling,Introduction to OOP in PHP,Working with Forms.

Module-3

JavaScript for Web Interactivity: JavaScript Basics – Variables, Operators, Functions, DOM, Events,Form Validation, and Integration with HTML/CSS.

Module-4

MySQL and PHP Integration: Introduction to MySQL,Database Concepts, SQL Queries (CRUD), Table Design,Connecting PHP to MySQL, Prepared statements and data handling.

Module-5

Web Application Features: Form validation (Client-side and Server-side),User authentication and session management,File uploads and downloads,Security practices (SQL Injection, XSS, CSRF),Hosting and deployment basics.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- **Luke Welling and Laura Thomson**, PHP and MySQL Web Development, 5th Edition, Addison-Wesley, 2016.
- **"PHP & MySQL: Novice to Ninja"** (6th Edition) **Author**: Tom Butler and Kevin Yank Publisher: SitePoint, 2022
- **"Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5" (5th Edition)** Author: Robin Nixon Publisher: O'Reilly Media, 2018

Weblinks and Video Lectures (e-Resources):

- https://www.youtube.com/live/s-iza7kAXME?si=cIV2baX4EjkzBGel
- https://youtu.be/btoVIlr7rAQ?si=PYiphzXfd0pij0op
- https://youtu.be/cGwSm8xDSwI?si=-ZTkFmBTVlUB0eOL

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the structure and components of web technologies.	L1
CO2	Develop web pages using HTML, CSS, and JavaScript.	L2
CO3	Design and interact with MySQL databases from PHP.	L3
CO4	Implement form validation and apply security measures in web apps.	L3,L4
CO5	Deploy a basic PHP-MySQL-based web application.	L4,L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2						
CO2	3	3	2					
CO3	3	3	2	2				
CO4	3	3	3	2	2			
CO5	3	3	3	3	3	2		

Semester- III

Enterprise Application Programming			
Course Code	**MMCB311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the architecture of enterprise applications.
- Develop server-side applications using Java EE/Spring.
- Work with databases and persistence layers using ORM tools.
- Design and implement secure, scalable, and distributed applications.
- Explore deployment strategies and enterprise application testing.

Module-1

Introduction to Enterprise Applications: Definition, Characteristics, types (ERP, CRM, SCM, etc.), and challenges,Enterprise application architecture and layers,Overview of Java EE, Spring Boot introduction,Ccomparison of monolithic vs micro services architecture.

Module-2

Web Development with Spring: Spring MVC and Controller,Dispatcher Servlet, Handler Mapping, Controller classes,Request Mapping, View Resolvers, Model And View, RESTful Web Services,REST API design, JSON processing,Creating REST controllers with Spring Boot.

Module-3

Business Logic and Dependency Injection: Spring Core & Bean Life cycle, Inversion of Control (IoC), Bean scopes, Configuration (XML/Java-based), Application Context, Service Layer and Transactions, Creating service classes, transaction management, AOP for business concerns (logging, security).

Module-4

Database Access and Persistence:JDBC and Spring JDBC Template,Data Source, connection pooling, querying with templates,Exception handling in JDBC,JPA and Hibernate with Spring,Entity classes, annotations, persistence context,Repositories and query methods.

Module-5

Security, Testing, and Deployment: Spring Security Fundamentals, Authentication, authorization, custom login forms, Securing REST APIs, Testing and Deployment:Unit testing (JUnit, Mockito), integration testing, WAR/JAR packaging, deploying on Tomcat, Docker basics.

Assessment Details (both CIE and SEE)

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The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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Semester-End Examination:

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2. The question paper will have ten full questions carrying equal marks.
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4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Spring in Action **Author:** Craig Walls**Edition:** 6th Edition (or latest available) **Publisher:** Manning Publications
- Enterprise Java Microservices: Building Scalable and Resilient Distributed Systems Author: **Ken Finnigan** Publisher: **O'Reilly Media**

Weblinks and Video Lectures (e-Resources):

- https://youtu.be/If1Lw4pLLEo?si=B3F-MHZ8q4N9vh_b
- https://youtu.be/UgX5lgv4uVM?si=GJLcXH9jior1_4pp

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand architecture and layers of enterprise applications.	L1
CO2	Build web applications using Spring MVC and REST.	L2
CO3	Implement service layers and apply dependency injection.	L3
CO4	Integrate database operations using JDBC, JPA, and Hibernate.	L3,L4
CO5	Secure, test, and deploy enterprise applications efficiently.	L4,L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**3**	**2**						
CO2	**3**	**3**	**2**					
CO3	**3**	**3**	**2**					
CO4	**3**	**3**	**2**					
CO5	**2**	**2**		1				

Semester- III

Advances in Web Technologies			
Course Code	**MMCB311E**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the syntax and usage of PHP for server-side scripting and develop basic web applications.
- Develop web applications using Ruby and Ruby on Rails with database integration.
- Design rich internet applications using AJAX and asynchronous communication principles.
- Implement AJAX patterns and manage complex XML Http Request scenarios.
- Apply responsive design principles using Bootstrap to create modern web interfaces.

Module-1

Introduction to PHP: Origins and uses of PHP, Overview of PHP, General syntactic characteristics, Primitives, operations and expressions, Output, Control statements, Arrays, Functions, Pattern matching. Building Web applications with PHP: Form handling, Files, Tracking users, cookies, sessions, Using databases, Handling XML.

Module-2

Introduction to Ruby and Introduction to Rails: Origins and uses of Ruby, Scalar types and their operations ,Simple input and output, Control statements, Arrays, Hashes, Methods, Classes, Code blocks and iterates, Pattern matching. Overview of Rails, Document requests, Processing forms, Layouts. Rails applications with Databases.

Module-3

Rich Internet Applications With Ajax: Limitations of Classic Web application model, AJAX principles, Technologies behind AJAX, Examples of usage of AJAX; Asynchronous communication and AJAX application model. Ajax with XML HTTP object: Part 1 Creating Ajax Applications: An example, Analysis of example ajax.html, Creating the JavaScript, Creating and opening the XML Http Request object, Data download, Displaying the fetched data, Connecting to the server, Adding Server-side programming, Sending data to the server using GET and POST.

Module-4

Ajax with XMLHTTP object: Part 2 Handling multiple XML Http Request objects in the same page, Using two XML Http Request objects, Using an array of XML Http Request objects, AJAX Patterns – Predictive Fetch, Multi-stage download, Periodic Refresh and Fall-back patterns, Submission throttling.

Module-5

Introduction to Bootstrap: What Is Bootstrap? Bootstrap File Structure, Basic HTML Template, Global Styles, Default Grid System, Basic Grid HTML, Offsetting Columns, Nesting Columns, Fluid Grid System, Container Layouts, Responsive Design. Typography, Emphasis Classes, Lists, Code, Tables, Optional Table Classes, Table RowClasses, Forms, Buttons, Images, Icons.

Assessment Details (both CIE and SEE)

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2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. obertW.Sebesta: Programming the Worldwide Web, 4thEdn, Pearson, 2012
2. Professional AJAX – Nicholas C Zakas et al, Wrox publications, 2008.
3. Steven Holzner: Ajax: A Beginner's Guide, Tata McGraw Hill, 2014.
4. Jake Spurlock: "Bootstrap: Responsive Web Development", O'Reilly Media, 2014.
5. Thomas A. Powel: Ajax The Complete reference, McGraw Hill,2008.
6. AravindShenoy, Ulrich Sossou: Learning Bootstrap, Packt, Dec 2014.
7. Dana Moore, Raymond Budd, Edward Benson: Professional Rich Internet Applications: AJAX andBeyond, Wiley 2012.

Weblinks and Video Lectures (e-Resources):

- https://www.php.net/manual/en/
- https://www.ruby-lang.org/en/documentation/
- https://guides.rubyonrails.org/
- https://developer.mozilla.org/en-US/docs/Web/Guide/AJAX
- https://getbootstrap.com/docs/5.3/getting-started/introduction/

Skill Development Activities Suggested

- Build a blog application with database interaction.
- Build a TODO web app using Ruby on Rails.Create a basic blog with CRUD operations using Rails and ActiveRecord. Handle form inputs and layouts dynamically in Rails.
- Develop a live search feature using AJAX. Create a weather info retriever using XMLHttpRequest and an API.
- Build a multi-tabbed interface with AJAX loading each tab's content. Use AJAX to periodically update a dashboard.
- Design a responsive portfolio website. Convert a static HTML form into a responsive Bootstrap-styled form. Style tables and buttons dynamically with Bootstrap classes.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain and use PHP for server-side scripting and web application development	L1,L2
CO2	Develop and deploy web applications using Ruby and Rails with database support	L3
CO3	Explain AJAX technology and build AJAX-enabled web applications	L3
CO4	Implement advanced AJAX functionalities using multiple XMLHttpRequest objects and AJAX patterns	L3,L4
CO5	Design responsive and styled web interfaces using Bootstrap framework	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2			2		3			
CO3	1			2				
CO4		2					3	
CO5					3			3

Semester- III

Web Programming using Java			
Course Code	**MMCB311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand web technologies and develop dynamic, interactive web applications using Java.
- To build client-server-based applications using Java Servlets and JSP.
- To integrate backend databases with web front-ends.
- To explore the MVC architecture in web development using Java frameworks.

Module-1

Introduction to Web Development and Java Web Technologies: Basics of Web Programming - HTTP, HTML, CSS, JavaScript overview. Introduction to Java EE, Architecture of Java Web Applications.

Module-2

Java Servlets**:** Servlet Lifecycle, Writing a basic Servlet, Deployment using web.xml, Servlet Config and Servlet Context, Request and Response Handling, Session Management, Cookies, and URL Rewriting, Redirecting requests (sendRedirect vs forward), Status codes and response headers.

Module-3

JavaServer Pages (JSP): Introduction to JSP and its advantages over Servlets,JSP Architecture, Implicit Objects, Scripting Elements, JSP Directives, Error Handling, JSTL (JSP Standard Tag Library), Advanced JSP Features.

Module-4

JDBC and Database Connectivity: Introduction to JDBC and its architecture, JDBC Drivers, Connection, Statement, ResultSet. Integrating JDBC with JSP and Servlets.

Module-5

MVC Architecture and Java Frameworks: MVC Architecture Pattern in Web Applications, Introduction to Spring MVC Framework -Controllers, Views, Models.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- *Web Programming using Java* **Author:** Uttam K. Roy **Publisher:** Oxford University Press **Edition:** Latest.
- **Java Web Programming and Web Services** Author: **David E. Flanagan** Publisher: **O'Reilly Media** Edition: **2nd Edition**
- **Head First Servlets and JSP** Authors: **Bryan Basham, Kathy Sierra, Bert Bates** Publisher: **O'Reilly Media** Edition: **2nd Edition.**

Web links and Video Lectures (e-Resources):

- https://youtu.be/BGTx91t8q50?si=PT8zIooy3p2J_awp
- https://youtu.be/Js4FlB0zTbg?si=XJNOQYzdpcTCLSdT
- https://youtu.be/r4EqfjMsP48?si=p9PbgbqebXYsqV_u

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamentals of web development and Java web technologies.	L1
CO2	Develop Java Servlet-based web applications.	L2
CO3	Create dynamic websites using JavaServer Pages (JSP).	L3
CO4	Integrate databases with Java web applications using JDBC.	L3
CO5	Apply MVC architecture for scalable Java web applications using frameworks.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3							
CO2	3							
CO3					2	2		
CO4	2	2	2					
CO5	2							2

Semester- III

Computer Networks			
Course Code	**MMCC311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hrs

Course Learning objectives: At the end of the course, the student will be able to

- Familiarize the basic terminologies used for computer networking.
- Implement the computer networks concepts like TCP/IP, IPC and Congestion avoidance techniques
- Simulate the working of wired networks and analyze its performance

Module-1

Introduction: Data Communications, Networks, The Internet, Broadcast and Point-To Point Networks; Connectionless and Connection-Oriented Services; Network Devices; Network Topologies; Types of Network: LAN, MAN, WAN,PAN; Server Based LANs and Peer-to-Peer LANs; Transmission Types; Modes of Communication;

Module-2

Network Models: Design Issues of the Layer, Protocol Hierarchy, ISO-OSI Reference Model: Functions of each Layer; Various Terminology used in Computer Network; Connection-Oriented and Connectionless Services, Internet (TCP/IP) Reference Model, Comparison of ISO OSI and TCP/IP Model.

Module-3

Transmission Media: Transmission Medium, Guided Media: Coaxial Cable, Twisted Pair, Fiber Optics Cable; Unguided Media: Radio Waves, Infrared, Micro-wave, Satellite communication, Laser. Switching Techniques.

Module-4

Data Link layer: Data link layer design issues, Error Detection and Correction Codes, Data Link Protocols (Simplex Stop-and-wait protocol for Error free and noisy channel) and Sliding window protocols.

Network Layer: Network Layer Design issues, Routing algorithms, Congestion Control Algorithms, Quality of Service, Internetworking and The Network Layer in the Internet.

Module-5

The Transport Layer: The Transport Service, Elements of Transport Protocols, Congestion Control, The Internet Transport Protocol: UDP, The Internet Transport Protocols – TCP.

The application Layer: DNS: Domain Name Space, Domain Resource Records, Domain Name Servers. Electronic mail: SMTP, The World Wide Web: Static and dynamic web pages, web applications, HTTP, mobile web. Streaming audio and Video: Digital audio and video, streaming stored and live media, Content delivery: Content and internet traffic, content delivery networks, peer-to-peer networks.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Behrouz A. Forouzan,: Data Communication and Networking, 4 th Edition Tata McGraw-Hill, 2006.
2. Alberto Leon-Garcia and Indra Widjaja: Communication Networks - Fundamental Concepts and Key architectures, 2nd Edition Tata McGraw-Hill, 2004.
3. William Stallings: Data and Computer Communication, 8th Edition, Pearson Education, 2007.
4. Larry L. Peterson and Bruce S. Davie: Computer Networks – A Systems Approach, 4th Edition, Elsevier, 2007.
5. Nader F. Mir: Computer and Communication Networks, Pearson Education, 2007.

Weblinks and Video Lectures (e-Resources):

- https://www.binghamton.edu/watson/continuing-education/data-science/intro-to-computer-networks.html
- https://elearn.daffodilvarsity.edu.bd/course/view.php?id=5457
- https://onlinecourses.nptel.ac.in/noc21_cs18/preview

Skill Development Activities Suggested

- The students with the help of the course teacher can take up technical –activities which will enhance their skill or the students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/testing/projects, and for creative and innovative methods to solve the identified problem. The prepared report shall be evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the basic concepts of networks like protocol, internet and OSI layers	L3
CO2	Analyze the working of Physical Layer.	L3
CO3	Demonstrate the various Switching networks	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2		**2**					1	
CO3		**2**	**3**					

Semester-III

Network and Linux Administration			
Course Code	**MMCC311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Set up and manage network interfaces, IP addresses, and network services.
- Configuration of firewalls using ip tables, NAT, and secure Linux networks.
- To Manage Network Services – Work with DNS, DHCP, remote login, and web server configurations.
- To Diagnose network issues and optimize performance using Linux tools.

Module 1:

Introduction to Networking :History and evolution of computer networking Basic network components and models **TCP/IP Networks** :Layers of the TCP/IP model Understanding IP addresses, subnetting, and classes The Internet Control Message Protocol (ICMP) **Linux Networking Basics :**Maintaining your Linux system for networking networking interfaces and configuration in Linux Overview of the /proc file system.

Module 2:

Configuring Serial Hardware : Communications software for modem links Accessing and managing serial devices Configuration utilities for serial communication **TCP/IP Configuration :** Understanding /proc for network-related data Configuring Linux-based TCP/IP networking **Name Services and DNS :**Resolver library overview How DNS works and alternatives to BIND.

Module 3:

Point-to-Point Protocol in Linux Running pppd and using options files, Automating dialing with chat ,IP configuration and link control options Security considerations and authentication in PPP **Advanced PPP Configurations :** Debugging PPP setups, PPPoE options in Linux, **Networking Security & Firewalls :** Understanding network security threats, Firewall concepts and IP filtering basics.

Module 4:

TCP/IP Firewalls : Methods of attack and security considerations, Netfilter and iptables basics, Setting up and managing Linux firewalls, **IP Masquerade & Network Address Translation:** Configuring the kernel for IP Masquerade, Handling NAT and DNS lookups **IP Accounting & Network Monitoring :** Configuring IP accounting Collecting and analyzing network data.

Module 5

Network Services and Remote Access : Understanding inetd, tcpd, and xinetd, Remote Procedure Call (RPC) configuration,Remote login and execution services **IPv6 & Web Server Configuration :**IPv4 limitations and introduction to IPv6, Configuring IPv6 networks in Linux, Apache Web Server setup and configuration. **Wireless Networking:** History and standards of wireless networking, Security concerns in 802.11b networks.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. **"Linux Network Administrator's Guide"** – Tony Bautts, Terry Dawson, Gregor N. Purdy 3rd edition

Reference Books:

1. "Computer Networking: A Top-Down Approach" – James F. Kurose & Keith W. Ross
   A great introduction to networking concepts, covering application-layer protocols, TCP/IP, and security.
   Link
2. "Linux Firewalls: Enhancing Security with nftables and Beyond" – Steve Suehring
   A comprehensive guide on firewall security, iptables, and nftables in Linux.
   Link
3. "Mastering Linux Network Administration" – Jay LaCroix
   Covers advanced Linux networking topics, including system administration and server configuration.
   Link

Weblinks and Video Lectures (e-Resources):

1. **Computer Networking Full Course** (Beginner-Friendly)
   - https://www.youtube.com/watch?v=qiQR5rTSshw (NetworkChuck – Cisco Basics & TCP/IP)
2. **Linux Networking & Firewall Setup**
   - https://www.youtube.com/watch?v=zA42YPS52Xo (TechWorld with Nana – Linux Networking Guide)
3. https://youtu.be/_eY4IfpbRDs?si=vHeCLsgFewCGJw3t

Skill Development Activities Suggested

Server Setup and Administration

- Install and configure Apache Web Server, DNS, and DHCP in Linux.
- Set up remote login (SSH) and secure authentication mechanisms.
- Set up and configure static & dynamic IP addressing using Linux commands.
- Use the ping, trace route, and net stat tools to diagnose network issues.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Learn about network setup, IP addresses, and how computers communicate.	L1
CO2	Configure internet connections, share files, and manage network settings.	L2
CO3	Protect a system from hackers by setting up firewall rules and security measures.	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**	**2**						
CO2		**2**		**3**				
CO3	**1**	**2**			**3**			**3**

Semester- III

TCP/IP			
Course Code	**MMCC311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- This course provides a solid foundation for understanding the communication process of the Internet.
- The student will understand the fundamental concepts of computer networking in the context of the TCP/IP model and protocols.
- 3. To study classful and classless addressing, IPV4,IPv6, UDP, TCP, congestion control and flow control.

Module-1

TCP/IP Protocol Suite - Protocol Layers, The TCP/IP Protocol suite and Addressing.IPV4 Addresses-Introduction, Classful and Classless Addressing, Internet Protocol Version4 (IPv4) – Datagram's, Fragmentation, Options, Checksum, Security, IP Package.

Module-2

Introduction to the Transport Layer: Transport Layer Services and Protocols. User Datagram Protocol (UDP) :Introduction,
User Datagram, UDP Services and Applications, UDP Package.

Module-3

Transmission Control Protocol – I: TCP Services: Process-to-Process Communication, Full-Duplex Communication, Multiplexing and De-multiplexing, Reliable Service, Connection-Oriented Service Features, Segment, TCP Connection, Windows in TCP.

Module-4

Transmission Control Protocol – II: Flow Control, Error Control, Congestion Control, TCP Timers, Options and TCP Package.

Module-5

IPv6 Addressing – Introduction, Address Space Allocation, Global Unicast Addresses, Auto configuration and Renumbering. IPv6 Protocol - Introduction, Packet Format, Transition from IPv4 to IPv6. ICMPv6 - Introduction, Error Messages, Informational Messages, Neighbor- Discovery Messages, Group Membership Messages.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. TCP/IP Protocol Suite, Behrouz A. Forouzan, 4th Edition, Tata McGraw-Hill Edition.
2. Data communication and Networking with TCP/IP Protocol Suite, Behrouz A. Forouzan, 6th Edition, Tata McGraw-Hill Edition.
3. The TCP/IP Tutorial and Technical Overview Adolfo Rodriguez, John Gatrell, John Karas, Roland Peschke

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=TBHHCd_9tz8
- https://www.youtube.com/watch?v=7GnSWC7ClNs

Skill Development Activities Suggested

- **Activity:** Study TCP/IP Model Layers: Learn about the four layers (Transport, and Transmission I and II) and how they compare to the OSI model.
- **Skills Developed:** Get the idea of the depth of Computer Networks.
- **Activity:** Protocol Deep Dive Explore protocols like TCP, IP, UDP etc.
- **Skills Developed:** Understanding the about the protocols and its use

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understanding of TCP/IP Architecture	L2
CO2	Identify and assign **IPv4 & IPv6 addresses** effectively.	L3
CO3	TCP & UDP Transmission Mechanisms	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**		**2**					
CO2		**2**		**3**				
CO3	**1**		**3**			**3**		

Semester- III

Unix Shell Programming			
Course Code	**MMCC311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- This course will enable students to
- To help the students to understand effective use of Unix concepts, commands and terminology. Identify, access, and evaluate UNIX file system
- Explain the fundamental design of the Unix operating system
- Familiarize with the systems calls provided in the Unix environment
- Design and build an application/service over the Unix operating system

Module-1

Introduction: Unix Components/Architecture. Features of Unix. The UNIX Environment and UNIX Structure, Posix and Single Unix specification. General features of Unix commands/ command structure. Command arguments and options. Basic Unix commands such as echo, printf, ls, who, date, passwd, cal, Combining commands. Meaning of Internal and external commands. The type command: knowing the type of a command and locating it. The root login. Becoming the super user: su command. Unix files: Naming files. Basic file types/categories. Organization of files. Hidden files. Standard directories. Parent-child relationship. The home directory and the HOME variable. Reaching required files- the PATH variable, manipulating the PATH, Relative and absolute pathnames. Directory commands – pwd, cd, mkdir, rmdir commands. The dot (.) and double dots (..) notations to represent present and parent directories and their usage in relative path names. File related commands – cat, mv, rm, cp, wc and od commands.

Module-2

File attributes and permissions: The ls command with options. Changing file permissions: the relative and absolute permissions changing methods. Recursively changing file permissions. Directory permissions. The shells interpretive cycle: Wild cards. Removing the special meanings of wild cards. Three standard files and redirection. Connecting commands: Pipe. Basic and Extended regular expressions. The grep, egrep. Typical examples involving different regular expressions. Shell programming: Ordinary and environment variables. The. profile. Read and read-only commands. Command line arguments. exit and exit status of a command. Logical operators for conditional execution. The test command and its shortcut. The if, while, for and case control statements. The set and shift commands and handling positional parameters.

Module-3

Unix Standardization and Implementations: Introduction, Unix Standardization, UNIX System Implementation. File I/O: Introduction, File Description, open, create, read, write, close, fcntl functions. Files and Dictionaries: mkdir and rmdir functions, reading dictionaries, chdir, fchdir and getcwd functions. Device Special files. The Environment of a UNIX Process: Introduction, main function, Process Termination, Command-Line Arguments, Environment List, Memory Layout of a C Program, Shared Libraries, Memory Allocation, Environment Variables, setjmp and longjmp Functions, getrlimit, setrlimit Functions.

Module-4

Process Control: Introduction, Process Identifiers, fork, vfork, exit, wait, waitpid, wait3, wait4 Functions, Race Conditions, exec Functions. Overview of IPC Methods, Pipes, popen, pclose Functions, Coprocesses, FIFOs, System V IPC, Message Queues, Semaphores. Shared Memory, Client-Server Properties, Passing File Descriptors, An Open Server-Version 1.

Module-5

Signals and Daemon Processes: Introduction, Signal Concepts, Signal Functions, SIGCLD Semantics, Kill and Raise functions, Alarm and Pause Functions, Signal Sets, sigprocmask Function, sigpending function, sigaction function, sigsetjmp and siglongjmp functions, sigsuspend function, abort function, system function, sleep, nanosleep and clock_nanosleep functions, sigqueue functions, job-control signals, signal names and numbers. Daemon Processes: Introduction, Daemon Characteristics, Coding Rules, Error Logging, Client-Server Model.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Sumitabha Das., Unix Concepts and Applications., 4thEdition., Tata McGraw Hill

2. W. Richard Stevens: Advanced Programming in the UNIX Environment, 2nd Edition, Pearson Education, 2005

Reference Books:

1. Unix System Programming Using C++ - Terrence Chan, PHI, 1999.

2. M.G. Venkatesh Murthy: UNIX & Shell Programming, Pearson Education.

3. Richard Blum, Christine Brenham: Linux Command Line and Shell Scripting Bible, 2ndEdition, Wiley, 2014.

Weblinks and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ffYUfAqEamY
- https://www.youtube.com/watch?v=Q05NZiYFcD0
- https://www.youtube.com/watch?v=8GdT53KDIyY
- https://www.youtube.com/watch?app=desktop&v=3Pga3y7rCgo

Skill Development Activities Suggested

- Demonstrate the basics of Unix concepts and commands.
- Demonstrate the UNIX file system.
- Apply comands to reflect changes in file system.
- Demonstrate IPC and process management.
- Develop an application/service over a Unix system.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand UNIX basics, navigate files and directories and use command-line interfaces.	L1
CO2	Manage user accounts, permissions, and system resources, create and edit files.	L2
CO3	Apply advanced UNIX concepts, including shell scripting, troubleshooting, and networking/security features.	L2,L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**			**2**				
CO2		**2**			**3**			
CO3	**1**		**3**				**3**	

Semester- III

Cloud Essentials			
Course Code	**MMCC311E**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Explain the fundamentals of cloud
- Analyse Business Benefits and Risks of Cloud Computing.
- Evaluate Emerging Trends in Cloud Computing

Module-1

Introduction to Cloud: Defining a cloud, Characteristics of Cloud Computing, Cloud computing reference model, Architectures for parallel and distributed computing, Elements of parallel computing and Elements of distributed computing.

Cloud Service Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Function as a Service (FaaS), Blockchain-as-a-Service (BaaS) and use cases, Cloud Deployment Models: Public Cloud, Private Cloud, Hybrid and Multi-Cloud, Community Cloud.

Module-2

Core Components of Cloud Architecture: Compute Services, Storage Services, Networking Services, Virtualization, Types of Virtualization, Containers vs. Virtual Machines (VMs), Load Balancing in Cloud, Auto-Scaling & Fault Tolerance, Content Delivery Networks(CDN), Bare Metal Cloud ,Cloud Orchestration and Automation.

Module-3

Cloud Automation, DevOps, and Future Innovations: Cloud Automation and Infrastructure as Code (IaC), DevOps and Continuous Integration/Continuous Deployment (CI/CD), Multi-Cloud and Hybrid Cloud Strategies, Sustainability and Green Cloud Computing, Cloud Innovations- AI-powered cloud automation-5G and its impact on cloud computing.

Module-4

Cloud Security & Risk Management: Cloud Adoption, Advantages and Challenges of Cloud Adoption, Security Risks in Cloud- Data Breaches, Identity Theft, Network Security in Cloud.

Security Solutions in Cloud: Identity and Access Management (IAM), Data Encryption Techniques, Firewalls & Intrusion Detection Systems: Compliance & Regulatory Frameworks, Disaster Recovery and Business Continuity Planning in Cloud.

Module-5

Emerging Trends and case study: AI, Edge Computing, Quantum Cloud, Event-driven architecture in cloud, Cloud-based AI services -AWS SageMaker, Google Vertex AI, Azure ML.

Case Study: Netflix's Cloud Migration, Zoom's Cloud Scalability.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **CompTIA Cloud Essentials+ Study Guide: Exam CLO-002 [2 ed.].**
2. Rajkumar Buyya, Christian Vecchiola, and Thamrai Selvi Mastering Cloud Computing McGraw Hill Education.
3. Handbook of Cloud Computing, Borko Furht- Armando Escalante.
4. Cloud Essentials: CompTIA Authorized Courseware for Exam CLO-001.
5. RjkumarBuyya, Christian Vecchiola, and ThamaraiSelci, Mastering Cloud Computing, Tata McGraw Hill, New Delhi, India, 2013.

Reference Book

1. Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M. Kanfman, F.Halper (Wiley India Edition)
2. Toby Velte, Anthony Velte, Cloud Computing: A Practical Approach, McGraw-Hill Osborne Media

Weblinks and Video Lectures (e-Resources):

- . https://youtu.be/dUpwh5XgxsA?si=pF4mgT2n5W7nyQFc
- https://www.youtube.com/watch?v=1N3oqYhzHv4
- https://www.youtube.com/watch?v=RWgW-CgdIk0

Skill Development Activities Suggested

- **Activity:** Develop a small web application using **PaaS** platforms like **Google App Engine** or **Heroku**
  Skills Developed: Hands-on experience with Platform-as-a-Service, web application hosting.
- **Activity:** Create and manage a free-tier account on **AWS, Azure, or Google Cloud Platform (GCP)**
  Skills Developed: Basic cloud navigation, account setup, and cloud resource management

The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate the fundamental concepts of cloud computing.	L2
CO2	Understand Cloud Security Challenges	L2
CO3	Understand and Explain Cloud Compute Services and Analyze Cloud Networking Services	L2
CO4	Compare different deployment and service models of cloud to develop different variety of applications with securities	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**							
CO2	**2**	**2**			**2**			
CO3	**2**	**2**			**3**			
CO4	**2**	**3**		**3**				**3**

Semester- III

Introduction to ERP and SAP Basis Administration			
Course Code	**MMCC311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Explain the objectives, importance, and decision phases of supply chain management.
- Evaluate ERP Implementation Processes
- Analyze the ERP Market and Leading Vendors
- Explain SAP system architecture, installation, and administration processes.

Module-1

Introduction to Supply Chain Management: Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.

Module-2

ERP Implementation: Implementation of Life Cycle, Implementation Methodology, Hidden Costs, Organizing Implementation, Vendors, Consultants and Users, Contracts, Project Management and Monitoring

Module-3

ERP Market: ERP Market Place, SAP AG, People Soft, Baan Company, JD Edwards World Solutions Company, Oracle Corporation, QAD, System Software Associates.

Module-4

Introduction to SAP Basis: System architecture, Installation/administration. User and role management, Transport Management System (TMS), Job\spool management, and database administration. System monitoring, troubleshooting, performance optimization, focusing on work processes, buffer tuning and memory management.

Module-5

Advanced SAP Basis & HANA: SAP patch management, system upgrades, security, audit logs, user access monitoring, backup and disaster recovery strategies. A brief introduction to SAP HANA: architecture , basic administration and case studies.

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

ERP assignments (Open-Source ERP Software to Use-Odoo (Community Edition)/ ERPNext/ Dolibarr**)**
1. Create a Company Profile – Set up a company in Odoo/ERPNext, enter details, and save.
2. Add a Product & Update Inventory – Create a product, set price & stock, then adjust inventory.
3. Generate a Sales Invoice – Create a customer, add a sales order, generate & export an invoice.
4. Add an Employee & Process Payroll – Create an employee, set salary, generate a payslip.
5. Generate a Business Report – Create a Sales, Inventory, or Financial Report, then export.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **"Supply Chain Management: Strategy, Planning, and Operation"** – *Sunil Chopra, Peter Meindl*
2. **"Enterprise Resource Planning: Fundamentals of Design and Implementation"** – *K. Ganesh, Sanjay Mohapatra*
3. **"SAP Basis Administration Handbook, NetWeaver Edition"** – *Ranjit Mereddy*
4. **"SAP HANA Administration"** – *Richard Bremer, Lars Breddemann*

Web links and Video Lectures (e-Resources):

- https://training.sap.com/content/sap-logistic-supply-chain
- https://www.sap.com/products/erp/what-is-erp.html.
- https://youtu.be/uuF746PiZ9k

Skill Development Activities Suggested

- **Hands-on ERP System Exploration** – Use an open-source ERP system like **Odoo** or **ERPNext** to understand real-world implementation, role management, and basic configurations.
- **Supply Chain Case Study Analysis** – Analyze a company's supply chain (e.g., Amazon, Toyota) to identify key drivers, challenges, and strategic decisions, then present findings in a report or presentation.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse the essentials of supply chain management in ERP.	L2
CO2	Analyse the implementation of ERP in the context of business of the different organization	L3
CO3	Analyse the given case study of ERP marketing.	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		**1**	**2**					
CO2		**2**	**1**	**3**				
CO3			**2**		**3**			

Semester- III

Management Information Systems			
Course Code	**MMCD311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the role and impact of information systems in global business environments.
- Analyse how organizations leverage information systems for strategic advantage.
- Evaluate the components and infrastructure of information systems, including databases and networking.
- Assess the applications of enterprise systems, e-commerce, and knowledge management in business processes.
- Apply principles of system development and project management to real-world scenarios.

Module-1

Foundations of Management Information Systems: Role of Information Systems in Business Today Global E-Business and Collaboration Information Systems, Organizations, and Strategy Ethical and Social Issues in Information Systems

Module-2

Information Technology Infrastructure: IT Infrastructure and Emerging Technologies Foundations of Business Intelligence: Databases and Information Management Telecommunications, the Internet, and Wireless Technology Securing Information Systems

Module-3

Enterprise Applications and E-Commerce: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications E-commerce: Digital Markets, Digital Goods Managing Knowledge and Artificial Intelligence

Module-4

Decision Making and System Development: Enhancing Decision Making Building Systems Managing Projects

Module-5

Managing Global Systems: The Growth of Global Business and Information Systems, Challenges of Global Information Systems, Organizing Global Business and Systems, Managing Global Systems Development, Strategies for Implementing Global Systems**,**Case Studies and Real-World Examples

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Pearson - Management Information Systems: Managing the Digital Firm
2. "Management Information Systems" by Raymond McLeod & George Schell
3. "Information Systems for Managers" by Gabriele Piccoli & Federico Pigni
4. "Essentials of Management Information Systems" by Kenneth C. Laudon & Jane P. Laudon

Weblinks and Video Lectures (e-Resources):

1. https://youtu.be/QrLZfvGJ5pw
2. https://youtu.be/dZP2J2tzSwc
3. https://www.youtube.com/watch?v=QrLZfvGJ5pw&list=PLim9gWjsjN-MpFDCjM5n2HfI9NFrsoDe6

Skill Development Activities Suggested

1. Conduct a business simulation where students run a virtual company.
2. Students act as CIOs, System Analysts, or Database Managers and solve a business problem collaboratively.
3. Students prepare posters, presentations, or videos promoting information security best practices.
4. Analyze real-world business cases involving successful or failed MIS implementations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamental concepts and types of Management Information Systems.	L1
CO2	Analyze how MIS supports decision-making and strategic business goals.	L2
CO3	Examine the components of IT infrastructure including databases, networks, and cloud.	L3
CO4	Evaluate enterprise systems, e-commerce, and knowledge-based systems in practice.	L3,L4
CO5	Design and manage system development processes and global information systems.	L4,L5

Mapping of COS and POs

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CLO1	3	2						
CLO2	3	3	2	2				
CLO3	2	3	3	2				
CLO4	2	3	2	3		2		
CLO5	2	2	3	3		3		

Semester- III

Database Design & Applications			
Course Code	**MMCD311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand database system concepts and data models.
- Design effective databases using ER models and normalization techniques.
- Write SQL queries for data manipulation and retrieval.
- Implement databases using popular RDBMS tools.
- Apply PL/SQL constructs to develop application-level logic.

Module-1

Introduction to Databases : File systems vs Database systems, Characteristics of database systems, DBMS architecture & data independence, Data models: Hierarchical, Network, Relational, Object-oriented, Database users & DBA roles.

Module-2

ER Modeling and Relational Model: Entity-Relationship model: Entities, attributes, relationships, ER diagrams, cardinality, participation, Mapping ER to relational schema, Relational algebra basics, Integrity constraints: Key, domain, referential integrity.

Module-3

SQL and Advanced SQL: Basics of SQL: DDL, DML, DCL, SQL queries: Selection, projection, joins, grouping, Sub-queries, nested queries, Views, indexes, sequences, Triggers and stored procedures.

Module-4

Normalization and Database Design : Functional dependencies, 1NF, 2NF, 3NF, BCNF, Multivalued dependencies, 4NF, 5NF, Decomposition and lossless joins, Case study: Designing a university database.

Module-5

PL/SQL and Applications : Introduction to PL/SQL, Cursors, loops, exception handling, Procedures and functions, Packages and triggers, Database connectivity using programming language (e.g., Python or Java)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **"Database System Concepts"** by Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw Hill Education
2. **"Fundamentals of Database Systems"** by Ramez Elmasri and Shamkant B. Navathe, Pearson Education
3. **"SQL, PL/SQL: The Programming Language of Oracle"** by Ivan Bayross
4. **"Modern Database Management"** by Jeffrey A. Hoffer, V. Ramesh, Heikki Topi
5. **"Learning SQL"** by Alan Beaulieu, O'Reilly

Weblinks and Video Lectures (e-Resources):

- https://sqlzoo.net/
- https://mode.com/sql-tutorial/
- https://oracle-base.com/

Skill Development Activities Suggested

- **Mini Project**: Design and develop a database-backed web/mobile application (e.g., Library, Hostel, Inventory Management).
- **Hands-on Lab**: Write complex SQL queries including joins, nested queries, and views.
- **ER Design Challenge**: Analyze a real-world system and model it using ER diagrams.
- **Normalization Lab**: Decompose messy schemas into normalized forms.
- **PL/SQL Hackathon**: Implement procedures, triggers, and error handling for a chosen application.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain database concepts and architectures	L1,L2
CO2	Design ER models and convert them into relational schemas	L3
CO3	Write SQL queries to retrieve and manipulate data	L3
CO4	Apply normalization techniques for effective schema design	L3
CO5	Develop PL/SQL programs and integrate with front-end applications	L4

Mapping of COS and Pos

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1						
CO2			1	2				
CO3					2	3		
CO4			1	2				3
CO5			2	2				

Semester- III

Software Architectures			
Course Code	**MMCD311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Describe the foundational concepts, components, and the significance of software architecture in the software lifecycle.
- Identify and apply appropriate architectural styles and patterns to different software system requirements.
- Analyze software architectures based on quality attributes such as performance, modifiability, and scalability.
- Use UML and architecture description languages (ADLs) to model and document software architectures.
- Critically evaluate real-world software architectures and understand their evolution and trade-offs through case studies.

Module-1

Introduction to Software Architecture Definition and significance, Architectural structures and views,Role of software architect,Architecture vs Design

Module-2

Architectural Styles and Patterns : Layered, Client-Server, Pipe-and-Filter, Event-driven, Microservices,Common architectural patterns: MVC, Broker, Blackboard, Service-Oriented,Design patterns review relevant to architecture

Module-3

Quality Attributes and Architecture Evaluation : Quality attributes: Performance, Security, Availability, Modifiability,Attribute-Driven Design (ADD),Architecture Tradeoff Analysis Method (ATAM),Tactics to achieve quality attributes

Module-4

Architecture Design and Documentation : Architecture modeling with UML,Views: Logical, Development, Process, Physical (4+1 view model),Documenting architecture (ADL, SAD),Case study-driven design

Module-5

Architecture in Practice : Architecture recovery and reengineering,Architecture and Agile development,Cloud-native and Microservices architectures ,Case studies of large-scale systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice," 4th Edition, Addison-Wesley, 2021
2. **Documenting Software Architectures: Views and Beyond** – *Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers*
3. **Software Architecture: Foundations, Theory, and Practice** – *Richard N. Taylor, Nenad Medvidovic, and Eric M. Dashofy*

Web links and Video Lectures (e-Resources):

- https://resources.sei.cmu.edu/library/subject-areas/software-architecture/
- https://www.tutorialspoint.com/software_architecture_design/index.htm
- https://learn.microsoft.com/en-us/azure/architecture/
- https://www.visual-paradigm.com/guide/uml-unified-modeling-language/

Skill Development Activities Suggested

1. Analyze architecture documentation of open-source projects (e.g., Apache Kafka, Spring Framework) to understand architecture decisions.
2. Implement mini-projects using common architectural styles such as MVC, Microservices, Layered Architecture, and Client-Server.
3. Use UML tools (like StarUML, Lucidchart) to model system architecture including component, deployment, and sequence diagrams.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Define and explain key software architecture concepts and their importance in the software development process.	L1
CO2	Identify and analyze various architectural styles and patterns and their applicability to different software applications.	L2
CO3	Evaluate software architectures based on quality attributes such as performance, security, and modifiability, and make informed decisions.	L3
CO4	Model, design, and document software architectures using appropriate tools, including UML and other architectural description languages (ADLs).	L3,L4
CO5	Apply software architecture principles through practical case studies, demonstrating the ability to solve real-world software architecture problems.	L4,L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2						
CO2	1	2	3	4				
CO3		2	3		5			
CO4		2	3		5			
CO5		2			5	6		

Semester- III

Computer Organization and Software Systems			
Course Code	**MMCD311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Acquire fundamental knowledge of computer architecture..
- Gain practical skills in assembly language programming.
- Analyze the interplay between hardware and software components.
- Develop and optimize software with an understanding of system constraints.

Module-1

Introduction to Computer Architecture: Overview of computer organization and architecture, Evolution of architectures (CISC, RISC, MIPS), Performance measures: CPI, MIPS, MFLOPS, Instruction sets and types, Structure of the CPU: ALU, CU, registers, Memory hierarchy: cache, main memory, virtual memory, Instruction pipelining and hazards, Memory addressing modes.

Module-2

Basics of Assembly Language: Assembly language structure and syntax, Data representation: binary, hexadecimal, Instruction formats and encoding, Arithmetic and logical operations,Data transfer instructions: MOV, LOAD, STORE, Stack operations: PUSH, POP, CALL, RET.

Module-3

Operating System Fundamentals: OS structure and functions, Process management and scheduling, Memory management techniques: paging and segmentation, Linkers and loaders: role and functionality, Device driver basics: kernel mode, user mode, Interaction between drivers and hardware.

Module-4

Storage Devices and Interfaces: Overview of primary and secondary storage, HDD, SSD, RAID configurations, Interfaces: SATA, SCSI, NVMe, Virtual memory concepts: paging and page replacement.

Module-5

Hardware-Software Co-Design and case study: Hardware-software partitioning, Performance optimization in co-design, Characteristics of embedded systems, Real-time operating system (RTOS) basics, Case study: Embedded systems development

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- **Title:** Computer Organization and Design: The Hardware/Software Interface **Authors:** David A. Patterson, John L. Hennessy **Edition:** 6th Edition **Publisher:** Morgan Kaufmann
- **Computer Organization and Architecture: Designing for Performance** Author: **William Stallings** Edition: **11th Edition** Publisher: **Pearson.**

Weblinks and Video Lectures (e-Resources):

- https://youtu.be/j8NnE1YeSN0?si=eP7qF3bv-92ps0tG
- https://youtu.be/-qyM8XJVnxg?si=Rks1jpJEcd0F_c_y

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the basic concepts of computer organization and architecture.	L1
CO2	Analyze the functioning of software systems and their interaction with hardware.	L2
CO3	Develop problem-solving skills using assembly language and low-level programming.	L2
CO4	Integrate concepts from computer architecture to design efficient software systems.	L3
CO5	Demonstrate the ability to apply software concepts in real-world scenarios.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2							
CO2	3							
CO3			3					
CO4	3	2	3		2			
CO5	2	2	3			2		

Semester- III

Software Design and Patterns			
Course Code	MMCD311E	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the importance and role of design patterns in software development.
- Learn how to implement various creational, structural, and behavioral design patterns.
- Analyze software design problems and apply appropriate design patterns to solve them.
- Develop reusable and maintainable object-oriented software.

Module-1

Fundamentals and Design Principles: Introduction to Design Patterns, Definition, purpose, and history, Benefits and limitations of design patterns, Classification: Creational, Structural, Behavioral. Principles of Object-Oriented Design, SOLID principles, Coupling and Cohesion, UML for patterns.

Module-2

Creational Design Patterns: Singleton and Factory Method, Singleton: ensuring a single instance, Factory Method: object creation interface, Abstract Factory: related object families, Builder: step-by-step complex object creation.

Module-3

Structural Design Patterns: Adapter and Decorator, Adapter: interface compatibility, Decorator: dynamic behavior extension, Composite and Proxy, Composite: tree-like structure, Proxy: controlling object access.

Module-4

Behavioral Design Patterns: Observer and Strategy, Observer: publish-subscribe systems, Strategy: interchangeable algorithms, Command and Template Method, Command: encapsulate requests, Template Method: algorithm skeleton

Module-5

Case Studies and Pattern Integration: State and Chain of Responsibility, State: dynamic behavior changes. Chain of Responsibility: passing request chains, Pattern combination in real systems, Anti-patterns and refactoring using patterns.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Title:** *Design Patterns: Elements of Reusable Object-Oriented Software*
   Authors: Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides
   Publisher: Addison-Wesley Professional
2. **Design Patterns: Elements of Reusable Object-Oriented Software**
   Authors: Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides (Gang of Four – GoF)

Reference book:

1. Head First Design Patterns *Authors:* Eric Freeman, Elisabeth Robson, Bert Bates, Kathy Sierra
Publisher: O'Reilly Media, 2004 / 2020 (2nd Ed. covers modern Java and updated patterns)

Weblinks and Video Lectures (e-Resources):

- https://youtu.be/4Dtv16aaNLQ?si=aaDLJtJHEx7xdGEy
- https://youtu.be/T9zbvi8eUW0?si=qCucZA4uFYSd-6Q8

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand fundamental concepts and classifications of design patterns.	L1
CO2	Apply creational patterns to construct flexible and reusable objects.	L2
CO3	Demonstrate the use of structural patterns for building scalable architectures.	L3
CO4	Implement behavioral patterns for effective communication among objects.	L3
CO5	Integrate multiple design patterns into a real-world software solution.	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2						
CO2	3		2					
CO3			2	2				
CO4	3	3	3		3			
CO5	3	2	3		3			

Semester- III

Object Oriented Analysis & Design			
Course Code	**MMCD311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamental concepts of object-oriented software development.
- Apply object-oriented principles such as abstraction, encapsulation, inheritance, and polymorphism in designing software systems.
- Analyze and model real-world problems using object-oriented analysis techniques.
- Develop design solutions applying object-oriented design patterns and principles.
- Evaluate and refine object-oriented design to meet quality attributes and software architecture standards.

Module-1

Introduction to OOAD : Evolution of software development methodologies, Introduction to Object-Oriented Software Development, Benefits and limitations of OOAD Comparison with Structured Analysis and Design, Key Concepts: Objects, Classes, Attributes, Methods, Messages, State, and Behaviour.

Module-2

Object-Oriented Principles: Abstraction and Encapsulation, Inheritance and Generalization, Polymorphism and Dynamic Binding, Object Reuse and Reusability, Aggregation and Composition, Coupling and Cohesion in OO Design.

Module-3

Object-Oriented Analysis: Gathering Requirements from the perspective of OO, Identifying Classes and Objects from problem statements, Responsibility Assignment, Identifying Relationships and Interactions, Class Responsibility Collaborator (CRC) Cards, Domain Modelling and Object Discovery.

Module-4

Object-Oriented Design: Principles of good OO Design (GRASP), Design for Change and Reuse, Applying Object Design Patterns (Factory, Singleton, Adapter, Strategy, Observer – Basic Understanding), Layered Architecture and Design Components, Design Metrics and Evaluation.

Module-5

Implementation and Case Studies: Translating Design to Code – Best Practices, Testing in OO Systems: Unit Testing, Integration Testing, Common Pitfalls in OOAD, Case Study: University Course Management & Evaluation System, Healthcare Appointment & Prescription System

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. .**Grady Booch** – *Object Oriented Analysis and Design with Applications*, Pearson Education.
2. .**Craig Larman** – *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development*, Pearson.
3. .**Ali Bahrami** – *Object Oriented Systems Development*, McGraw Hill.
4. .**James Rumbaugh, Michael Blaha** – *Object-Oriented Modeling and Design with UML*, Pearson Education.
5. Grady Booch "Object-Oriented Analysis and Design with Applications"
6. **Erich Gamma et al.** – *Design Patterns: Elements of Reusable Object-Oriented Software*, Addison Wesley.

Weblinks and Video Lectures (e-Resources):

- https://refactoring.guru – Design Patterns explained with examples
- https://sourcemaking.com/design_patterns – Comprehensive guide to patterns
- https://martinfowler.com – Software design and architecture blogs
- https://www.geeksforgeeks.org – Object-oriented programming and design tutorials
- https://www.tutorialspoint.com – OOAD topics simplified

Skill Development Activities Suggested

1. Mini project: Design an object-oriented system (e.g., Library Management, E-commerce).
2. Identify classes, responsibilities, and relationships in real-life applications.
3. Case study analysis of existing OO-based software.
4. Peer review of object-oriented design diagrams.
5. Write class diagrams and responsibility charts for a given use case

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe fundamental concepts and principles of object-oriented software development.	L1
CO2	Identify objects and classes from real-world problems and model them using OOA concepts.	L2
CO3	Apply object-oriented principles in the design of software systems.	L3
CO4	Use appropriate design patterns for building flexible and reusable systems.	L3
CO5	Analyze object-oriented solutions and apply best practices in coding and testing.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1					
CO2		3	2	1				
CO3			3	2	1		3	
CO4	3	3	3	2	2			3
CO5	3				2	1		3

Semester- III

Mobile Computing			
Course Code	**MMCE311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Define concepts of wireless communication.
- Compare and contrast propagation methods, Channel models, capacity calculations multiple antennas and multiple user techniques used in mobile communication.
- Explain CDMA, GSM. Mobile IP, WiMAX and Different Mobile OS
- 4. Illustrate various Markup Languages CDC, CLDC, MIDP; Programming for CLDC, MIDlet model, and security concerns

Module-1

Mobile Computing Architecture: Architecture for Mobile Computing, 3-tier Architecture, Design Considerations for Mobile Computing. Emerging Technologies: Wireless broadband (WiMAX), Mobile IP: Introduction, discovery, Registration, Tunneling, Cellular IP, Mobile IP with IPv6. Wireless Networks : Global Systems for Mobile Communication (GSM): GSM Architecture, Entities, Call routing in GSM, PLMN Interface, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management, GSM Frequency allocation. Short Service Messages (SMS): Introduction to SMS, SMS Architecture, SMMT, SMMO, SMS as Information bearer, applications

Module-2

GPRS and Packet Data Network: GPRS Network Architecture, GPRS Network Operations, Data Services in GPRS, Applications for GPRS, Billing and Charging in GPRS. Spread Spectrum technology, IS-95, CDMA versus GSM, Wireless Data, Third Generation Networks, Applications on 3G, Mobile Client: Moving beyond desktop, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices.

Module-3

Mobile OS and Computing Environment: Smart Client Architecture, The Client: User Interface, Data Storage, Performance, Data Synchronization, Messaging. The Server: Data Synchronization, Enterprise Data Source, Messaging. Mobile Operating Systems: WinCE, Palm OS, Symbian OS, Linux, Proprietary OS Client Development: The development process, Need analysis phase, Design phase, Implementation and Testing phase, Deployment phase, Development Tools, Device Emulators

Module-4

Building Wireless Internet Applications: Thin client overview: Architecture, the client, Middleware, messaging Servers, Processing a Wireless request, Wireless Applications Protocol (WAP) Overview, Wireless Languages: Markup Languages, HDML, WML, 10 Hours HTML, cHTML, XHTML, VoiceXML.

Module-5

J2ME: Introduction, CDC, CLDC, MIDP; Programming for CLDC, MIDlet model, Provisioning, MIDlet life-cycle, Creating new application, MIDlet event handling, GUI in MIDP, Low level GUI Components, Multimedia APIs; Communication in MIDP, Security Considerations in MIDP.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Ashok Talukder, Roopa Yavagal, Hasan Ahmed: Mobile Computing, Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill, 2010.
2. Martyn Mallik: Mobile and Wireless Design Essentials, Wiley India, 2003

Reference Books:

1. Raj kamal: Mobile Computing, Oxford University Press, 2007.
2. Iti Saha Misra: Wireless Communications and Networks, 3G and Beyond, Tata McGraw Hill, 2009.

Web links and Video Lectures (e-Resources):

- https://youtu.be/GT-tYP8RGIs?si=8fs7TgNVN8-ej-TU
- https://youtu.be/OxdUs9E8Aps?si=93ur91NnDVmtY5zS
- https://youtu.be/QWwLtCE_8cY?si=NIbSTijMEkcq7IgC

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain state of art techniques in wireless communication.	L1
CO2	Discover CDMA, GSM. Mobile IP, WImax	L2
CO3	Demonstrate program for CLDC, MIDP let model and security concerns	L3
CO4	Building Wireless Internet Applications	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2							
CO2	2						2	
CO3			2					
CO4	3	2	3		3			

Semester- III

Data Storage Technologies and Networks			
Course Code	**MMCE311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Learn to apply storage resource management tools for efficient system monitoring and resource allocation.
- Learn performance optimization techniques to enhance storage system efficiency and reliability.
- Explore data encryption methods and access control strategies to secure sensitive information and ensure compliance.
- Explore emerging trends in storage, including software-defined storage, NVMe technology, and the CompTIA Storage+ certification.

Module-1

Fundamentals of Data Storage

Direct Attached Storage (DAS), Network Attached Storage (NAS), Storage Area Networks (SAN), storage devices such as HDDs, SSDs, and tape drives, and RAID principles and configurations including various levels for data protection.

Module-2

Storage Area Networks (SAN)

SAN architecture, Fibre Channel SAN, iSCSI SAN, SAN topologies, zoning, Host Bus Adapters (HBAs), switches, cabling, performance tuning, and troubleshooting strategies for SAN environments.

Module-3

Networked and Cloud Storage

File-level storage systems with protocols such as NFS and SMB, object-based storage like S3, unified storage systems, cloud storage models including public, private, hybrid, and the integration of storage in virtualized environments.

Module-4

Data Services and Optimization

Data replication methods (local and remote), snapshot technologies, storage virtualization, deduplication, compression techniques, backup and recovery strategies, business continuity, and disaster recovery planning.

Module-5

Storage Management and Security

Storage resource management tools, monitoring, performance tuning, data encryption, access control mechanisms, audit trails, emerging trends such as software-defined storage, NVMe, and CompTIA Storage.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources: Books

1. "Introduction to Storage Area Networks" by Jon Tate
2. Cloud Computing Concepts, Technology & Architecture Thomas Erl, Zaigham Mahmood, and Ricardo Puttini

Web links and Video Lectures (e-Resources):

- https://www.geeksforgeeks.org/storage-area-networks/
- https://www.youtube.com/watch?v=HP3Z48VnZjk&pp=ygUzZGF0YSBzdG9yYWdlIHRlY2hub2xvZ2llcyBhbmQgbmV0d29ya3MgZnVsbCBjb3Vyc2Ug
- https://youtu.be/4FJJGNnHOfc

Skill Development Activities Suggested

1. Hands-on Workshop: Setting Up a NAS (Network Attached Storage) System
2. Practical Task: Exploring Cloud Storage Services
3. Mini Project: RAID Configuration and Benchmarking
4. Case Study + Presentation: Modern Storage Technologies in Enterprise Networks

Course outcome (Course Skill Set)

Sl. No.	Description	Blooms Level
CO1	Develop the ability to explain the fundamentals of data storage technologies including DAS, NAS, SAN, HDDs, SSDs, tape drives, and RAID configurations.	L2
CO2	Demonstrate the configuration and performance tuning of SAN components like Fibre Channel, iSCSI, zoning, HBAs, and switche	L3
CO3	Demonstrate the working of file-based and object-based storage (NFS, SMB, S3) and analyze their use in virtualized and cloud environments.	L3,L4
CO4	Design data replication, backup, and disaster recovery strategies using snapshots, deduplication, and storage virtualization techniques.	L5
CO5	Demonstrate the ability to apply encryption, access control, and monitoring tools while exploring emerging trends in storage technologies.	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2							
CO2			3					
CO3	3		3					
CO4	3							
CO5	2	3		2	3			3

Semester- III

Design and Operation of Data Centres			
Course Code	**MMCE311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamental concepts of data centres, their types, and their roles in modern IT infrastructure.
- Learn the key components of a data centre, including servers**,** storage systems**,** networking**,** and power/cooling systems**.**
- Explain the importance of scalability**,** availability**,** and reliability in data centre design.
- Identify the industry standards and best practices for data centre design, including Uptime Institute classifications.
- Discuss the process of site selection**,** facility planning, and space optimization for efficient data centre operations.

Module-1

Overview of Data Centres: Architecture and Evolution: Introduction to Data Centres, Evolution of Data Centres, Data Centre Architecture, Data Centre Design and Implementation, Types of Data Centres **On-Premises, Cloud, and Hybrid On-Premises Data Centres**: Cloud Data Centres, Benefits of Cloud Data Centres, Challenges and Risks, Comparing Data Centre Types

Module-2

Data Centre Network Architecture: Introduction to Network Architecture in Data Centres, Data Centre Network Topologies, Network Virtualization in Data Centres, Redundancy and Fault Tolerance, Security in Data Centre Networks, Introduction to Power Systems in Data Centres, Disaster Recovery and Business Continuity

Module-3

Space Management and Physical Security: Space Management in Data Centres, Physical Security in Data Centres, Security and Compliance Standards, Redundancy in Data Centres, Redundant Cooling Systems, Scalability in Data Centres, Fault Tolerance in Data Centres, High Availability Models.

Module-4

Data Centre Operations and Management: Introduction to Data Centre Monitoring, Types of Monitoring Systems, Management Protocols and Tools, Incident Management and Troubleshooting, Data Centre Energy Management, Introduction to Automation in Data Centres, Automation Tools and Platforms, Virtualization Technologies in Data Centres, Virtualization Management and Monitoring.

Module-5

Security Management in Data Centres: Physical Security in Data Centres, Cybersecurity in Data Centres**,** Security Monitoring and Incident Response, Disaster Recovery Planning (DRP), Backup and Data Replication Strategies, Testing and Updating Disaster Recovery Plans.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbook:

1. "Data Center Handbook" by **Hwaiyu Geng** (McGraw-Hill Professional, 2015)
2. Cloud Data Centers and Cost Modeling: A Complete Guide to Planning, Designing, and Building a Cloud Data Center" by Hwaiyu Geng

Web links and Video Lectures (e-Resources):

- https://youtu.be/wZzQBI628Hs?si=k3HAFHnalvDWF_Y4
- https://youtu.be/saQGWdOHfzM?si=1FRJoAbaclOdHooT

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the fundamentals of data centre design, architecture, and operations.	L1
CO2	Analyze the various components involved in the infrastructure and environment of data centres.	L2
CO3	Explore best practices and technologies for maintaining data centre operations, security, and sustainability.	L3
CO4	Evaluate network architecture, power and cooling mechanisms in data centres.	L3
CO5	Security Management in Data Centres	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2						2	
CO2	2							
CO3			3		2	2		
CO4	3	3	3					
CO5								

Semester- III

Wireless and Mobile Communication			
Course Code	**MMCE311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- **Explain** the fundamentals of wireless communication systems, propagation models, and the evolution from 1G to 5G technologies.
- **Analyze** wireless channel characteristics and apply appropriate modulation techniques for efficient data transmission.
- **Evaluate** the design principles of cellular systems, including frequency reuse, handoff, and interference management.
- **Compare** the architecture and protocols of major mobile communication systems like GSM, CDMA, LTE, and 5G.
- **Design** wireless networks considering MAC protocols, mobility management, and routing mechanisms in dynamic environments.

Module-1

Introduction to Wireless Communication Systems: Evolution of wireless communication: From 1G to 5G, characteristics of wireless communication vs. wired communication,Cellular networks (GSM, CDMA, LTE, 5G), Wireless LANs and PANs (Wi-Fi, Bluetooth, Zigbee), Satellite, Paging, and RFID systemsm, Basics of electromagnetic wave propagation, Propagation mechanisms, Types of propagation models, Empirical path loss models.

Module-2

Wireless Channel and Modulation: Fading,Types of Fading, Multipath Effects, Statistical Channel Models, **Channel Impulse Response (CIR),** Time and Frequency Selectivity, Overview of Modulation Schemes, Digital Modulation Techniques-BPSK,QPSK, Spread Spectrum Techniques- Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS), Concept and relevance in LTE and 5G.

Module-3

Cellular System Design Fundamentals: Introduction to cells, cell clustering, and hexagonal cell structure, Reuse of frequencies and frequency planning, Cell Splitting and Sectoring, Handoff Techniques, Hard handoff vs. soft handoff, Handoff in GSM and CDMA systems, Interference in Cellular Systems and its types.

Module-4

GSM and CDMA Systems: GSM System Architecture, Mobile Station, Base Station Subsystem, Network and Switching Subsystem, Base Transceiver Station (BTS), Mobile Switching Center (MSC), GSM Services- Bearer services, teleservices, and supplementary services, Basic Concepts of CDMA- Spread spectrum and orthogonality, Use of pseudo-random codes, CDMA System Architecture, Channel Structure in CDMA.

Module-5

Wireless Networks and Mobility Management: WLAN, WLAN Architecture, MAC Layer Functionality, WLAN Frame Format and Types, Security in WLAN.PAN, Bluetooth protocol stack (L2CAP, RFCOMM), Piconets and Scatternets, Zigbee and Infrared, Mobility Management- Types of Mobility, Mobility Management Techniques, Challenges in Mobility Management, Routing in Mobile Networks, Mobile IP.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books.

Textbook:

1. **Theodore S. Rappaport**, *"Wireless Communications: Principles and Practice"*, 2nd Edition, Pearson Education, 2023 (latest reprint).

2. Wireless Communications" by Andrea Goldsmith, **Publisher:** Cambridge University Press

Web links and Video Lectures (e-Resources):

- https://youtu.be/8T7orRAQgic?si=ke1agkiLMSyPczLC
- https://youtu.be/PIfOY5z3HI4?si=QE37fJygRAUHCDrb

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand wireless communication systems and propagation models.	L1
CO2	Analyze wireless channel characteristics and modulation techniques.	L2
CO3	Evaluate cellular system design and interference management techniques.	L3
CO4	Compare mobile communication systems (GSM, CDMA, LTE, 5G) and their features.	L3
CO5	Design and analyze wireless networks and mobility management techniques.	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3						
CO2	2							
CO3								
CO4	2	3	3			2		
CO5	2	3	3	2				

Semester- III

Software Defined Networks			
Course Code	**MMCE311E**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Apply the fundamentals of Software Defined Networks for the given problem
- Illustrate the basics of Software Defined Networks Operations and Data flow
- Apply different Software Defined Network Operations and Data Flow
- Analyse alternative definitions of Software Defined Networks
- Apply different Software Defined Network Operations in real world problem

Module-1

Introduction to SDN :Understanding the SDN, Understanding the SDN technology, Control Plane, Data Plane, Moving information between planes, separation of the control and data planes, Distributed control planes, Load Balancing, Creating the MPLS Overlay, Centralized control planes.

Module-2

Working of SDN:Evaluation of Switches and Control planes, SDN Implications, Data centre Needs, Forerunner of SDN, Software Defines Networks is Born, Sustain SDN interoperability, Open source contribution, Fundamental Characteristics of SDN, SDN Operations, SDN Devices, SDN Controllers, SDN Applications, Alternate SDN methods.

Module-3

The Open Flow Specifications:Open Flow Overview, Open Flow Basics, Open Flow 1.0 additions, Open Flow 1.1 additions, Open Flow 1.2 additions, Open Flow 1.3 additions, Open Flow limitations.

Module-4

SDN via APIS, SDN via Hypervisor-Based Overlays, SDN via Opening up the device, Network function virtualization, Alternative Overlap and Ranking.

Module-5

Data centres: definition, Data centres demand, tunnelling technologies for Data centres Path technologies in data centres, Ethernet fabrics in Data centres, SDN use case in Data centres.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Software Defined Networking by Thomas D Nadeau and Ken Gray.
2. Software Define Networks, A Comprehensive Approach, Paul Goransson, Chuck Black. MK Publications.

References:

1. Software Defined Networking for Dummies brought you by cisco, Brian Underdahl and Gary Kinghorn.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=nUN40N91fJ4&list=PLJ6vZHpRUoJNn-3F918wKpAtr6gGUOixc
- https://youtu.be/WdTHHXOl8kg?si=3TjSR6p954i3Fm98
- https://youtu.be/_961s5WGkok?si=Zj6ejHH5SEQVk3TN

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the fundamentals of Software Defined Networks for the given problem	L1
CO2	Illustrate the basics of Software Defined Networks Operations and Data flow	L2
CO3	Apply different Software Defined Network Operations and Data Flow	L3
CO4	Analyse alternative definitions of Software Defined Networks	L3
CO5	Apply different Software Defined Network Operations in real world problem	L3

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2						
CO2	2							
CO3			3		3		3	
CO4	3	2						
CO5	3	2						

Semester- III

Cloud Computing			
Course Code	**MMCE311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Explain the fundamentals of cloud computing
- Illustrate the cloud application programming and aneka platform
- Contrast different cloud platforms used in industry

Module-1

Introduction to Cloud Computing: Eras of computing, The vision of Cloud Computing, Defining a cloud, A closer look, Cloud computing reference model, Historical developments: Distributed systems, Virtualization, Web 2.0; Service oriented computing; Utility oriented computing.

Module-2

Architectures for parallel and distributed computing: Parallel Vs Distributed computing, Elements of parallel computing, Elements of distributed computing, Technologies for distributed computing.

Module-3

Virtualization: Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples: Xen: Para virtualization, VmWare: Full virtualization, Microsoft Hyper – V.

Module-4

Cloud computing architecture: Introduction, Cloud reference model: Architecture, IaaS, PaaS, SaaS, Types of Clouds: Public, Private, Hybrid and Community clouds, Economics of the cloud, Open challenges.

Module-5

Cloud Platforms in Industry : Amazon web services; Google AppEngine; Microsoft Azure; Cloud Applications. Scientific applications: Healthcare; Biology; Geo-Science, Business and Consumer applications: ARM & ERP; Productivity; Social networking.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Textbooks

1. RjkumarBuyya, Christian Vecchiola, and ThamaraiSelci, Mastering Cloud Computing, Tata McGraw Hill, New Delhi, India, 2013

Reference Books

1. Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M. Kanfman, F.Halper (Wiley India Edition)

2. Cloud Computing: A Practical Approach by J.Vette, Toby J. Vette, Robert Elsenpeter (Tata McGraw Hill).

Web links and Video Lectures (e-Resources):

- https://youtu.be/dmGybCohHsw?si=9idoJWu5C8GI2Lr6
- https://youtu.be/2LaAJq1lB1Q?si=Hi4UWAJOw1fML0YV
- https://youtu.be/RmuVkB3siYY?si=MT6IqmW8p3PytQGF

Skill Development Activities Suggested

Skill Development Activity The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate the fundamental and core concepts of cloud computing	L1
CO2	Compare between parallel and distributed computing	L2
CO3	Investigate the system virtualization and outline its role in enabling the cloud computing system model	L3
CO4	Compare different deployment and service models of cloud to develop different variety of applications	L3

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2							
CO2	2						2	
CO3					2			
CO4	2	3	3					

Semester- III

Introduction to Generative AI			
Course Code	**MMCF311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the Fundamentals of Generative AI
- Master in Core Generative AI Models: GANs, VAEs, and Diffusion Models
- Develop Practical Skills in Generative AI Using Popular Frameworks
- Explore the Ethical Implications and Social Impact of Generative AI
- Apply Generative AI to Real-World Applications

Module-1
Introduction to AI and Machine Learning-Types of Generative Models (e.g., LLM,SLM,GANs, VAEs, Autoregressive Models)- Neural Networks: Basic Architecture, Backpropagation, Activation Functions-Deep Learning Basics and its Applications-Unsupervised vs. Supervised Learning
Module-2
Introduction to Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs)-Understanding the Generator-Discriminator Architecture in GANs-Latent Space Representation and Loss Functions-Training Strategies, Optimization, and Hyperparameter Tuning-Applications and Case Studies in Image, Video, and Text Generation-Diffusion Models and their Use in Modern AI Art Generation
Module-3
Introduction to TensorFlow and PyTorch for Generative AI Building GANs and VAEs from Scratch Hands-on Projects: Generating Images, Music, and Text - Model Evaluation Techniques (FID Score, Inception Score, BLEU Score) - Fine-tuning Pretrained Models for Specialized Applications
Module-4
Ethical Challenges in AI: Bias, Fairness, and Accountability- Deepfakes and Synthetic Media: Risks and Regulations - AI in Content Creation: Copyright, Ownership, and Creativity - Data Privacy in Generative AI Systems - Bias and Fairness in Training Data: Identifying and Mitigating
Module-5
AI in Digital Art and Content Creation - Music Generation Using Neural Networks - Healthcare Applications: Drug Discovery and Medical Imaging - Natural Language Generation (NLG) and Chatbots - Case Studies: Generative AI in Gaming, Fashion, and Virtual Reality

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Gohil, P.** (2019). *Machine learning with Tensor Flow*. BPB Publications.
2. **Akerkar, R.** (2020). *Deep learning: A practitioner's approach*. Springer.
3. **Arora, R.** (2021). *Artificial intelligence: A guide for thinking humans*. Wiley India Pvt. Ltd.
4. **Schwab, K.** (2017). *The fourth industrial revolution* (Indian edition). Penguin Random House India.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=rwF-X5STYks
- https://www.youtube.com/watch?v=6aZiboOfYRA
- https://www.youtube.com/shorts/W5nwke7iw8c
- https://www.youtube.com/watch?v=t64TZ5S-IeY
- https://www.youtube.com/watch?v=Hv4oyBthaqs

Skill Development Activities Suggested

AI-Generated Art and Creativity

- **Objective:** Encourage creativity using generative models.
- **Task:** Have students use AI models like StyleGAN or DeepDream to generate unique pieces of art. Encourage them to experiment with the style transfer and image manipulation capabilities of these models.
- **Outcome:** Students will explore the intersection of AI and creativity, understanding how generative AI can be used in the arts.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the Fundamentals concepts of Generative AI	L2
CO2	Identify the performance of generative models using metrics	L2
CO3	Analyze the ethical implications of generative AI	L4
CO4	Apply algorithms to build and train generative models using frameworks	L3
CO5	Compare the performance of various generative AI architectures	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1						
CO2	2				1			
CO3		2						1
CO4	2				2			
CO5					2	1		

Semester- III

Artificial Neural Networks			
Course Code	**MMCF311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the Fundamentals of Artificial Neural Networks
- Learn the Training Process of Neural Networks
- Explore Different Neural Network Architectures
- Implement Neural Networks Using Frameworks
- Understand Practical Applications and Limitations of Neural Networks

Module-1

Overview of Artificial Intelligence and Machine Learning - What are Neural Networks? Introduction to Neurons and Perceptrons - Structure of an ANN: Layers (Input, Hidden, Output)- Activation Functions: Sigmoid, ReLU, Tanh - Introduction to Feedforward Networks

Module-2

Forward Propagation and Loss Functions - Introduction to Gradient Descent and Backpropagation Learning Rate and Optimization Algorithms (e.g., Stochastic Gradient Descent, Adam) - Overfitting and Regularization Techniques (e.g., Dropout, L2 regularization) - Introduction to Epochs and Batch Processing

Module-3

Single-Layer vs. Multi-Layer Perceptrons (MLPs) - Convolutional Neural Networks (CNNs) for image processing - Recurrent Neural Networks (RNNs) for sequence data - Autoencoders and their applications - Introduction to Transfer Learning

Module-4

Introduction to TensorFlow and PyTorch- Implementing a Simple Neural Network with PyTorch/TensorFlow - Data Preprocessing and Loading Datasets - □ Training, Testing, and Evaluating Models - Hyperparameter Tuning and Model Optimization

Module-5

Applications of Neural Networks in Image Recognition, Natural Language Processing, and Time Series Prediction-Neural Networks for Classification vs. Regression-Common Pitfalls in Neural Network Training-Ethical Considerations and Model Interpretability-Future Trends in Neural Networks and Deep Learning

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks**
   to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Deepa, S. N.** (2020). *Artificial Neural Networks: A Practical Approach*. Wiley India Pvt. Ltd.
2. **Patel, M., & Patel, A.** (2019). *Artificial Neural Networks: Applications and Implementations*. BPB Publications
3. **Gupta, S. K.** (2017). *Introduction to Neural Networks using MATLAB 6.0*. Tata McGraw-Hill Education.

Weblinks and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=jmmW0F0biz0
- https://www.youtube.com/watch?v=mlk0rddP3L4
- https://www.youtube.com/watch?v=oJNHXPs0XDk
- https://www.youtube.com/watch?v=Wo5dMEP_BbI&list=PLQVvvaa0QuDcjD5BAw2DxE6OF2tius3V3
- https://www.youtube.com/watch?v=rEDzUT3ymw4

Skill Development Activities Suggested

- The students will implement a simple **Feedforward Neural Network (FNN)** to classify the **MNIST dataset** (handwritten digits) using **TensorFlow** or **PyTorch**.
- The task will involve loading the dataset, pre-processing the data, defining the neural network architecture, training the model, and evaluating its performance.
- Have students use AI models like StyleGAN or DeepDream to generate unique pieces of art. Encourage them to experiment with the style transfer and image manipulation capabilities of these models.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the principles of Neural Networks	L2
CO2	Analyze the feed-forward neural networks	L4
CO3	Identify different types of models of neural networks	L3
CO4	Implement ANN using frameworks	L4
CO5	Compare different applications of artificial neural networks	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2							
CO2	2				2			
CO3		2						
CO4		2						
CO5		2				2	2	

Semester- III

Natural Language Processing			
Course Code	**MMCF311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the Fundamentals of Natural Language Processing
- Learn Text Pre-processing Techniques
- Implement Basic NLP Models
- Explore Word Embeddings and Advanced NLP Models
- Understand NLP Applications and Real-World Use Cases

Module-1

Introduction to NLP: Definition and scope - Basic Linguistic Concepts: Syntax, Semantics, and Pragmatics - Language Models: Unigram, Bigram, and N-grams - Overview of NLP Tasks: Text classification, Named Entity Recognition (NER), Sentiment Analysis, etc. - Key Applications of NLP: Machine Translation, Speech Recognition, Chatbots

Module-2

Text Cleaning: Removing special characters, punctuation, stop words, and irrelevant data - Tokenization: Word-level and sentence-level tokenization - Stemming and Lemmatization: Understanding and applying common text normalization techniques - Text Vectorization: Bag-of-Words (BoW), TF-IDF, Word Embeddings (Word2Vec, GloVe) - Part-of-Speech (POS) Tagging: Introduction to syntactic categories

Module-3

Introduction to Machine Learning for NLP: Supervised vs. Unsupervised Learning - Building a Text Classification Model: Naive Bayes, Logistic Regression, and SVM for text classification - Sentiment Analysis: Using basic machine learning models for sentiment classification - Introduction to Deep Learning for NLP: Feedforward Neural Networks for text - Evaluating NLP Models: Accuracy, Precision, Recall, and F1-score

Module-4

Word Embeddings: Introduction to Word2Vec and GloVe - Semantic Analysis: Understanding word similarity, cosine similarity, and vector-based word representations - Neural Networks for NLP: Simple architectures like RNNs and LSTMs -Introduction to Transformer Models: Basic understanding of BERT and GPT - Language Representation Models and Fine-tuning

Module-5

Named Entity Recognition (NER): Techniques for identifying entities in text-Text Summarization: Extractive vs. Abstractive Summarization-Machine Translation: Introduction to rule-based, statistical, and neural machine translation systems-Chatbots and Conversational AI: Building simple conversational agents using NLP-Ethical Considerations: Bias in NLP models and ethical implications of NLP applications

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Kumar, V., & Dey, L.** (2019). *Introduction to Natural Language Processing*. Wiley India Pvt. Ltd..
2. **Sahani, M., & Dey, L.** (2021). *Natural Language Processing: Techniques and Applications*. McGraw-Hill Education.
3. **Rai, M. (2019).** *Foundations of Natural Language Processing*. Oxford University Press.
4. **Prasad, R., & Rani, N.** (2020). *Natural Language Processing with Python: A Practical Guide*. BPB Publications.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=aeOLjFe256E&list=PLD392E2ACAEF0C689
- https://www.youtube.com/watch?v=zG8AJhVy5NY&list=PLD392E2ACAEF0C689&index=2
- https://www.youtube.com/watch?v=dBEpW4h2Gig&list=PLD392E2ACAEF0C689&index=6
- https://www.youtube.com/watch?v=kfssS6bD5FQ&list=PLD392E2ACAEF0C689&index=7
- https://www.youtube.com/watch?v=iWbkjwe-xag&list=PLD392E2ACAEF0C689&index=12

Skill Development Activities Suggested

- Students will use **Python** and **scikit-learn** (or another machine learning library) to implement a **text classification model**. The task involves preprocessing text data, feature extraction using TF-IDF, training a machine learning model, and evaluating its performance.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the basic concepts of Natural Language Processing	L2
CO2	Apply text pre-processing techniques	L3
CO3	Apply Machine Learning Algorithms to NLP Tasks	L3
CO4	Implement and train word embedding models (Word2Vec, GloVe) on text corpora	L4
CO5	Analyze the ethical considerations in NLP applications	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**							
CO2	**2**		**2**					
CO3	**2**				**2**			
CO4	**2**				**1**			
CO5	**1**	**1**						**2**

Semester- III

Deep Learning Fundamentals			
Course Code	**MMCF311D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the fundamentals of deep learning
- Understanding the working of Convolutional Neural Networks and RNN in decision making.
- Illustrate the strength and weaknesses of many popular deep learning approaches.
- Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems

Module-1

Introduction: What is a Neural Network? The Human Brain, Models of a Neuron, Neural Networks Viewed As Directed Graphs, Feedback, Network Architectures

Rosenblatt's Perceptron: Introduction, Perceptron, The Perceptron Convergence Theorem, Relation Between the Perceptron and Bayes Classifier for a Gaussian Environment.

Textbook 1: Introduction 1, (1- 6), Ch 1, (1.1 - 1.4)

Module-2

Multilayer Perceptrons: Introduction, Some Preliminaries, Batch Learning and On-Line Learning, The Back-Propagation Algorithm, XOR Problem, Heuristics for Making the Back- Propagation Algorithm Perform Better, Computer Experiment: Pattern Classification, Back Propagation and Differentiation.

Textbook 1: Ch 4, (4.1- 4.8)

Module-3

Regularization for Deep Learning: Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under Constrained Problem, Dataset Augmentation, Semi-Supervised Learning.

Optimization for Training Deep Models: How Learning Differs from pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rate.

Textbook 2: Ch 7, (7.1 – 7.6), Ch 8, (8.1 – 8.5)

Module-4

Convolution Networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, The Neuroscientific Basic for Convolutional Network, Convolutional Networks and the History of Deep Learning.

Textbook 2: Ch 9, (9.1 – 9.11)

Module-5

Sequence Modeling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to- Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and Other Gated RNNs.

Textbook 2: Ch 10, (10.1-10.6), 10.10

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks

1. Simon Haykin, Neural networks and Learning Machines, Third Edition, Pearson, 2016
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

Reference book

3. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning, 2009
4. N.D. Lewis, "Deep Learning Made Easy with R: A Gentle Introduction for Data Science", January 2016
5. Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly publications

Weblinks and Video Lectures (e-Resources):

https://www.deeplearningbook.org/lecture_slides.html
https://www.youtube.com/watch?v=VyWAvY2CF9c
https://www.youtube.com/watch?v=7sB052Pz0sQ
https://www.youtube.com/watch?v=Mubj_fqiAv8
https://www.coursera.org/learn/neural-networks-deep-learning
https://onlinecourses.nptel.ac.in/noc20_cs62/preview

Skill Development Activities Suggested

- Mini projects (2 to 4 students) using Deep Learning concepts

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understanding Deep Learning Fundamentals	L2
CO2	Design and Implementation of Neural Networks	L3
CO3	Optimization and Performance Tuning	L3
CO4	Application of Advanced Deep Learning Architectures	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2		2		2				
CO3								
CO4			1,2					3

Semester- III

Introduction to Machine Learning			
Course Code	**MMCF311E**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- To understand the basic theory underlying machine learning, types, and the process.
- To become familiar with data and visualize univariate, bivariate, and multivariate data using statistical techniques and dimensionality reduction.
- To understand various machine learning algorithms such as similarity-based learning, regression, decision trees.
- To familiarize with learning theories, probability-based models, and reinforcement learning, developing the skills required for decision-making in dynamic environments.

Module-1

Introduction to Machine Learning: Need for Machine Learning, Machine Learning Explained, Machine Learning in Relation to Other Fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Machine Learning Application.

Understanding Data: Introduction, Big Data Analytics and Types of Analytics, Big Data Analysis Framework, Descriptive Statistics, Univariate Data Analysis and Visualization, Bivariate Data and Multivariate Data.

Textbook 1: Ch 1, 1.1-1.7, Ch 2, 2.1-2.6

Module-2

Understanding Data: Multivariate Statistics, Essential Mathematics for Multivariate Data, Overview of Hypothesis, Feature Engineering and Dimensionality Reduction Techniques.

Basics of Learning Theory: Introduction to Learning and its Types, Introduction to Computation Learning Theory, Design of a Learning System, Introduction to Concept Learning, Induction Biases, Modelling in Machine Learning.

Textbook 1: Ch 2, 2.7-2.10, Ch 3 3.1 – 3.6

Module-3

Similarity-based Learning: Introduction to Similarity or Instance-based Learning, Nearest-Neighbor Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR).

Regression Analysis: Introduction to Regression, Introduction to Linearity, Correlation, and Causation, Introduction to Linear Regression, Validation of Regression Methods, Multiple Linear Regression, Polynomial Regression, Logistic Regression.

Textbook 1: Ch 4, 4.1 – 4.5, Ch 5, 5.1 – 5.7

Module-4

Decision Trees Learning: Introduction to Decision Tree Learning model, Decision Tree Induction Algorithms, Validating and Pruning of Decision Trees.

Bayesian Learning: Introduction to Probability-based Learning, Fundamentals of Bayes Theorem, Classification Using Bayes Model.

Textbook 1: Ch 6, 6.1 – 6.3, Ch 8, 8.1 – 8.3

Module-5

Artificial Neural Networks: Introduction, Biological Neurons, Artificial Neurons, Perceptron and Learning Theory, Types of Artificial Neural Network.

Reinforcement Learning: Overview and Scope of Reinforcement Learning, Components of Reinforcement Learning, Q-Learning.

Textbook 1: Ch 10, 10.1-10.5, Ch 14, (14.1, 14.2, 14.4, 14.9)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks

1. S Sridhar and M Vijayalakshmi, "Machine Learning", Oxford University Press, 2021.
2. M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press (India) Pvt. Limited, 2024.

Reference Books

3. Tom M. Mitchell, "Machine Learning," McGraw-Hill Education, 2013.
4. Miroslav Kubat, "An Introduction to Machine Learning," Springer, 2017.

Web links and Video Lectures (e-Resources):

https://www.universitiespress.com/resources?id=9789393330697
https://onlinecourses.nptel.ac.in/noc23_cs18/preview
https://www.geeksforgeeks.org/machine-learning/
https://www.w3schools.com/python/python_ml_getting_started.asp
https://www.tutorialspoint.com/machine_learning/index.html

Skill Development Activities Suggested

- Course project by taking suitable machine learning-based real-world application problem

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understanding ML Fundamentals	L2
CO2	Applying ML Algorithms	L3
CO3	Model Evaluation and Optimization	L3
CO4	Practical Implementation and Problem-Solving	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2		2		3				
CO3								
CO4			2					2

Semester- III

Computer Vision			
Course Code	**MMCF311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the Fundamentals of Computer Vision
- Implement Feature Extraction and Object Recognition
- Analyze Motion and Video Processing Techniques and Apply Deep Learning in Computer Vision

Module-1

Introduction to Computer Vision and Image Representation: Basics of Computer Vision and its applications, Digital images: Pixels, resolution, and color models, Image formation and perception Visualizing pixel intensity distributions, Working with pixel-based operations, Introduction to video processing

Module-2

Feature Detection and Image Processing Techniques: Edge detection techniques (Sobel, Canny) Line and corner detection, Gaussian kernels and filters, Delaunay mesh segmentation, Voronoi mesh applications in vision.

Module-3

Shape and Object Recognition: Contour detection and shape analysis, Feature extraction methods Maximal nucleus clusters and Lowe keypoints, Image segmentation techniques, Introduction to object tracking in videos

Module-4

Computational Geometry and Machine Vision: Concepts of computational topology in vision Linear filtering and transformations, Spatial relationships and image transformations, Use of graphs and meshes in object representation, Real-time and offline video analysis

Module-5

Advanced Topics and Applications: Deep learning for computer vision (basics) , Convolutional Neural Networks (CNNs) overview, Applications in biometrics, medical imaging, and robotics . Future trends in computer vision , Case studies and project discussions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Peters, J. F. (2017). *Foundations of computer vision: Computational geometry, visual image structures, and object shape detection*. Springer International Publishing
2. Szeliski, R. (2022). *Computer vision: Algorithms and applications* (2nd ed.). Springer.
3. Forsyth, D. A., & Ponce, J. (2011). *Computer vision: A modern approach* (2nd ed.). Pearson.

Web links and Video Lectures (e-Resources):

- . https://www.youtube.com/channel/UCf0WB91t8Ky6AuYcQV0CcLw
- https://www.youtube.com/watch?v=2w8XIskzdFw
- https://16385.courses.cs.cmu.edu/spring2021/lectures
- https://github.com/kuzand/Computer-Vision-Video-Lectures

Skill Development Activities Suggested

Implementing Basic Image Processing Techniques: Activity: Perform image transformations like grayscale conversion, blurring, edge detection (Sobel, Canny), and thresholding using OpenCV.

Feature Detection and Key point Matching: Activity: Implement SIFT, SURF, and ORB algorithms to detect features in images and match them between two scenes.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understanding Image Processing Fundamentals	L2
CO2	Apply Feature Extraction and Object Recognition techniques	L3
CO3	Understand Motion Analysis and Video Processing methods	L2
CO4	Utilize deep learning models like CNNs for image classification and segmentation.	L3
CO5	Evaluate the performance of different computer vision techniques for practical applications.	L4

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**							
CO2	**2**							
CO3	**2**							
CO4	**2**							
CO5		**2**						

Semester- III

Data Management for IoT			
Course Code	**MMCG311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Explain the fundamental concepts, architecture, and communication protocols of IoT, including smart devices, RFID, and wireless sensor networks.
- Analyze IoT network connectivity, data exchange formats, and web integration techniques for efficient IoT communication.
- Apply data acquisition, storage, cloud computing, and analytics techniques to manage IoT data effectively.
- Evaluate IoT security challenges, privacy concerns, and identity management strategies to ensure data protection.
- Develop IoT prototypes, integrate IoT gateways, and analyze business models for real-world applications and Industry 4.0.

Module-1

Introduction to IoT and System Architecture (8 hours): Vision and Definitions of IoT**,** Smart Hyperconnected Devices and IoT Applications**,** IoT Conceptual Framework and Architectural Views**,** IoT Communication Protocols: MQTT, CoAP, XMPP**,** Sources of IoT Data: RFID, Wireless Sensor Networks**,** Wearable Technologies, Smart Homes, Smart Cities

Module-2

IoT Connectivity, Communication, and Web Integration (8 hours): IoT Network and Connectivity Principles: IPv4, IPv6, 6LoWPAN, TCP/IP, IP Addressing, MAC Addressing, IETF Six-Layer Design for IoT, Communication Protocols: HTTP, HTTPS, FTP, Telnet, Web Connectivity & Data Exchange: JSON, MIME, TLV Data Formats, REST, SOAP, Web Sockets, MQTT

Module-3

IoT Data Management and Analytics (8 hours): Data Acquisition and Storage: Data Validation, Events Assembly, Data Store Processes, SQL vs NoSQL Databases, Spatial & Time-Series Databases, Cloud Data Processing for IoT: SaaS, IaaS, PaaS, DaaS, XaaS Models, Cloud Platforms (AWS IoT, TCS Connected Universe), Cloud-Based Data Storage & Computing, IoT Data Analytics: Descriptive, Real-time, Predictive Analytics, Business Intelligence & Big Data for IoT

Module-4

IoT Security, Privacy, and Threat Management (8 hours): IoT Security Challenges: Vulnerabilities & Threat Analysis, Identity Establishment & Access Control, IoT Security Architecture: Layered Attacker Models, IoT Security Tomography, Data Privacy Considerations: Use Cases and Misuse Cases, Blockchain for IoT Security.

Module-5

IoT Prototyping, Applications, and Business Models (8 hours): Prototyping IoT Devices and Embedded Systems: Arduino, Intel Galileo, Raspberry Pi, BeagleBone, mBed**,** IoT Gateway Development & API Integration**,** IoT in Industrial Applications (Industry 4.0): Connected Vehicles (Tesla Example), Smart Cities**,** Smart Agriculture, Smart Production**,** Business Models & IoT Innovation: Value Creation using IoT**,** IoT-driven Business Strategies

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **"Internet of Things: Principles and Paradigms"** – Rajkumar Buyya & Amir Vahid Dastjerdi *Covers IoT architecture, communication protocols, cloud integration, and security concepts.*
2. **"Internet of Things: A Hands-on Approach"** – Arshdeep Bahga & Vijay Madisetti *Practical guide with IoT prototyping using Raspberry Pi, Arduino, and cloud platforms*
3. **"Building the Internet of Things: Implement New Business Models, Disrupt Competitors, and Transform Your Industry"** – Maciej Kranz
4. **"Data Management for the Internet of Things"** – C. Müller, S. Karnouskos
5. **"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things"** – David Hanes, Gonzalo Salgueiro, Patrick Grossetete

Web links and Video Lectures (e-Resources):

Web Links

- **IoT Fundamentals & Architecture** – Cisco Networking Academy: Introduction to IoT
- **IoT Communication Protocols** – MQTT Essentials by HiveMQ
- **IoT Security & Privacy** – NIST Guidelines for IoT Security
- **IoT Data Management & Analytics** – Google Cloud IoT Documentation
- **IoT Business Models & Applications** – IBM IoT Solutions

Video Lectures & Online Courses

- **IoT Basics & Applications** – Coursera: The Internet of Things by University of California
- **IoT Data Management & Cloud Computing** – AWS IoT Core Tutorials
- **IoT Security & Privacy** – Stanford Cybersecurity & Internet of Things`

Skill Development Activities Suggested

- **IoT Architecture & Communication** – Experiment with RFID, wireless sensor networks, and MQTT. Simulate network protocols (IPv4, IPv6, TCP/IP, CoAP) using tools like Cisco Packet Tracer.
- **IoT Data Management & Cloud Integration** – Work with SQL/NoSQL databases (MongoDB, Firebase), use cloud platforms (AWS IoT, Google Cloud IoT) for data storage, and analyze IoT data using Python and visualization tools.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the fundamental concepts, architectures, communication protocols, and data sources of IoT, including smart devices, RFID, and wireless sensor networks.	L2
CO2	Analyse IoT network architectures, communication protocols, data exchange formats, and web integration techniques for seamless IoT connectivity.	L4
CO3	Apply data acquisition, storage, cloud computing, and analytics techniques to process and manage IoT data effectively.	L3
CO4	Evaluate IoT security challenges, privacy concerns, identity management, and emerging security frameworks for safeguarding IoT data.	L5
CO5	Develop IoT prototypes, integrate IoT gateways and APIs, and analyse real-world applications and business models for IoT innovation.	L6

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3				2			
CO2	3							
CO3			3	3	3		2	
CO4	3	3					2	
CO5			3				3	

Semester- III

Networked Embedded Applications			
Course Code	**MMCG311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To expose the students to the fundamentals of wired embedded networking techniques.
- To introduce the concepts of embedded ethernet.
- To expose the students to the fundamentals of wireless embedded networking.
- To discuss the fundamental building blocks of digital instrumentation.
- To introduce design of Programmable measurement & control of electrical Device.

Module-1

NETWORK EMBEDDED SYSTEMS: AN INTRODUCTION

Networked Embedded Systems: Networking of Embedded Systems- Automotive Networked Embedded Systems Networks-Embedded Systems in Industrial Automation- Wireless Sensor Networks- Networked Embedded Systems in Building Automation – Middleware Design and Implementation for Networked Embedded Systems- Introduction- Middleware Solution Space ORB Middleware for Networked Embedded Systems.

Textbook 1: Ch. 1,2

Module-2

WIRELESS SENSOR NETWORKS

Introduction To WSNS- Architecture for WSNS- Localization & Synchronization for WSN- Time Sync Issues & Resource Aware Localization.

Textbook 1: Ch. 3,4,5,6

Module-3

ENERGY-EFFICIENT MAC PROTOCOLS FOR WSN

Design Issues for MAC Protocols for WSNs, Overview on Energy-Efficient MAC Protocols for WSNs, Mobility Support in WSNs, Multichannel Protocols for WSNs, Summary and Open Issues.

Textbook 1: Ch. 8

Module-4

AUTOMOTIVE NETWORKED EMBEDDED SYSTEMS

Trends in Automotive Communication Systems, Time –Triggered Communication, Flex Ray Communications, Lin Standards.

Textbook 1: Ch. 13,14,16,17

Module-5

INDUSTRIAL AUTOMATION

Introduction To Industrial Automation, Fieldbus Bus – What Is a Fieldbus, Communication Fundamental, The OSI Model Fieldbus Characteristics, Networking Networks, Interconnection in Heterogeneous Environments, Industrial Ethernet, The New Fieldbus, Real-Time Ethernet-Home Automation Home Automation-Introduction-Structure of the IEC Standardization, Real-Time Requirements, Practical Realizations.

Textbook 1: Ch. 20

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. R.Zurawski, Network Embedded Systems, Crc Press, 2009.
2. G.Pottie, W.Kaiser, Principles of Embedded Networked System Design
3. Raj Kamal, Embedded Systems, Tata McGraw Hill, New Delhi, 2003
4. Francine Krief,"Communicating Embedded System" Wiley 2010.

Web links and Video Lectures (e-Resources):

1. https://youtu.be/aYfBTXXhK70?si=QwkwzAfzGt34ESP2
2. https://youtu.be/JO4AEkOVF2M?si=625mOK9NIuaP6Gn-
3. https://youtu.be/vn7aT9-cYzQ?si=eiEV3iiLAzJlIWYI
4. https://youtu.be/runrFcCsC1E?si=FGDXIXMtjNd1VykP

Skill Development Activities Suggested

1. Hands-on Simulation and Implementation.
2. IoT and Embedded Systems Prototyping.
3. Security and Optimization in Embedded Networks.

Course outcome (Course Skill Set)
At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the basics of network systems.	L1
CO2	Discuss about the sensor network components, architecture and design principles of WSN	L2, L3
CO3	Explain the need MAC protocols and energy conservation.	L2
CO4	Application of networked automotive system.	L3
CO5	Design and development of home automation	L3

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**							
CO2		**2**						**2**
CO3						**2**		
CO4				**3**				
CO5			**1**					

Semester- III

Cross Platform Application Development			
Course Code	**MMCG311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand Cross-Platform Development Fundamentals
- Install and configure cross-platform development environments.
- Implement responsive UI designs that adapt to different screen sizes and resolutions.
- Write code using languages like Dart (Flutter) and Implement core application functionality using reusable code components.

Module-1

Introduction to Dart - Getting started with Dart, The evolution of Dart, How Dart works, Dart VM and JavaScript compilation, Dart development tools, Understanding why Flutter uses Dart, Introducing the structure of the Dart language, Dart operators, Type checking and casting, Dart types and variables, Type inference – bringing dynamism to the show, Control flows and looping, Functions, Data structures, collections, and generics, Introduction to OOP in Dart, Dart OOP features- Objects and classes, Encapsulation, Inheritance and composition, Abstraction, Polymorphism

Text Book 1 – Chapter 1

Module-2

Intermediate Dart Programming- Dart classes and constructors, Field accessors – getters and setters, Static fields and methods, Class inheritance, Interfaces, abstract classes, and mixins, Callable classes, top-level functions, and variables, Understanding Dart libraries and packages, Creating Dart libraries, Dart packages, Package structures, Stage hand – the Dart Project Generator, The pubspec file, Pckage dependencies – pub, Introducing async programming with Futures and Isolates, Itroducing Unit testing with Dart

Text Book 1 - Chapter 2

Module-3

An Introduction to Flutter - Comparisons with other mobile app development frameworks, Flutter compilation (Dart), Flutter rendering, Widgets introduction, Hello Flutter -Running the generated project.

The Flutter User Interface – Widgets: Building Layouts in Flutter - Stateful versus stateless widgets, Built-in widgets, Understanding built-in layout widgets, Creating a UI with widgets, Creating custom widgets

Text Book 1 - Chapter 3 and Chapter 4

Module-4

Handling User Input and Gestures- Handling user gestures, Input Widgets, , Validating Inputs (Forms), Custom input and Form Field.

Theming and Styling - Theme widgets, Material Design, Using Custom Fonts, Dynamic styling with MediaQuery and LayoutBuilder

Text Book 1 - Chapter 5 and Chapter 6

Module-5

Routing: Navigating between Screens- Understanding the Navigator widget, Named routes, Screen transitions, Hero animations

Developing Fully Featured Apps – Firebase Plug-in - Firebase Overview, Firebase authentication, NoSql Database with Cloud Fire store

Text Book 1 - Chapter 7 and Chapter 7

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Flutter for Beginners - Alessandro Biessek, Published by Packt Publishing Ltd.**

   ISBN 978-1-78899-608-2

Web links and Video Lectures (e-Resources):

Web Links

- Official Docs: https://flutter.dev/docs
- Flutter YouTube Channel: https://www.youtube.com/c/FlutterDev
- Dart Programming: https://dart.dev

Skill Development Activities Suggested

1. Basic Hands-on Activities

Setup & Environment Configuration

- Install and configure cross-platform development tools (Flutter, React Native, Xamarin).
- Set up IDEs like VS Code, Android Studio, and Xcode.

Hello World App

- Create a simple cross-platform application displaying a text message

2. Responsive UI Development

Design and implement adaptive layouts

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the fundamental concepts, benefits, and challenges of cross-platform application development.	L2
CO2	Compare different cross-platform frameworks (Flutter, React Native, Xamarin) and select the appropriate one for a given application.	L4
CO3	Design and implement responsive and adaptive user interfaces for cross-platform applications.	L3
CO4	Design and develop basic user interfaces that are responsive across multiple platforms and screen sizes.	L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**2**	**2**			**2**			
CO2	**2**		**2**		**2**			
CO3			**3**		**3**			**3**
CO4								
CO5			**2**		**2**			

Semester- III

IoT Technology and Applications			
Course Code	**MMCG311D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- To understand the concepts of Internet of Things and the application of IoT.
- To Explore IoT Architectures and Technologies.
- Examine IoT Communication and Networking.
- Apply IoT Solutions in Real-World Scenarios.

Module-1

What is The Internet of Things? Overview and Motivations, Examples of Applications, IPV6 Role, Areas of Development and Standardization, Scope of the Present Investigation. Internet of Things Definitions and frameworks-IoT Definitions, IoT Frameworks, Basic Nodal Capabilities. Internet of Things Application Examples-Overview, Smart Metering/Advanced Metering Infrastructure Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking, Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications.

Textbook1: Ch1: 1.1 – 1.5, Ch2: 2.1 – 2.3, Ch3: 3.1 – 3.11

Module-2

Fundamental IoT Mechanism and Key Technologies-Identification of IoT Object and Services, Structural Aspects of the IoT, Key IoT Technologies. Evolving IoT Standards-Overview and Approaches, IETF IPV6 Routing Protocol for RPL Roll, Constrained Application Protocol, Representational State Transfer, ETSI M2M, Third Generation Partnership Project Service Requirements for Machine-Type Communications, CENELEC, IETF IPv6 Over Low power WPAN, Zigbee IP(ZIP), IPSO.

Textbook1: Ch4: 4.1 – 4.3, Ch5: 5.1 – 5.10

Module-3

Layer ½ Connectivity: Wireless Technologies for the IoT-WPAN Technologies for IoT/M2M, Cellular and Mobile Network Technologies for IoT/M2M, Layer 3 Connectivity: IPv6 Technologies for the IoT: Overview and Motivations. Address Capabilities, IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Migration Strategies to IPv6.

Textbook1: Ch6: 6.1 - 6.2, Ch7: 7.1 - 7.8

Module-4

Case Studies illustrating IoT Design-Introduction, Home Automation, Cities, Environment, Agriculture, Productivity Applications.

Textbook2: Ch9: 9.1 - 9.6

Module-5

Data Analytics for IoT: Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study.

Textbook2: Ch: 10.1 - 10.8

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks

1. Daniel Minoli: Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Wiley, 2013.
2. ArshdeepBahga, Vijay Madisetti: Internet of Things: A Hands-on Approach, Universities Press, 2015.

Reference Books

1. Michael Miller: The Internet of Things, Pearson, First Edition, 2015.
2. Claire Rowland, Elizabeth Goodman et.al: Designing Connected Products, O'Reilly, First Edition, 2015.

Web links and Video Lectures (e-Resources):

- http://download.e-bookshelf.de/download/0000/8067/18/L-G-0000806718-0002366365.pdf
- https://jcer.in/jcer-docs/E-Learning/Digital%20Library%20/E-Books/Internet-of-things-a-hands-on-approach-%20Arshadeep.pdf

Skill Development Activities Suggested

- Students focus on developing IoT-based solutions for smart cities, healthcare, home automation, agriculture, and environmental monitoring. Students will design systems for traffic management, remote health monitoring, smart security, precision farming, and real-time pollution tracking. These hands-on projects will enhance their skills in IoT hardware, cloud integration, AI-driven analytics, and real-time system development for real-world applications.

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Use of Devices, Gateways and Data Management in IoT.	L2
CO2	Design IoT applications in different domain and be able to analyze their performance	L3
CO3	Implement basic IoT applications on embedded platform.	L4
C04	Implement basic IoT applications for Data Analytics	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		**1**				**2**		
CO2			**1**					
CO3						**2**		**3**
CO4		**3**						

Semester- III

Communication and Networking Technologies in IOT			
Course Code	**MMCG311E**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand fundamentals of IoT architecture outline and standards.
- Understand and analyze different architectural views.
- Understand the importance of IoT Layer Protocols.
- Understand the importance of architecture and Industrial Internet of Things.

Module-1

Introduction: IoT Technology trends and future opportunities, IoT and Business scope Evolution, Business perspectives, Embedded systems Relationships, Challenges of IoT, Characteristics of IoT, Sensors and Actuators in IoT enabling Industrial Automation, Wireless sensor Networks in IoT, connecting all the things in Internet of things, IoT M2M, Software Define Networking. IoT System Management is Essential.

Text Book1: Ch1, 1.1-1.13

Module-2

Introduction IOT life cycle, Physical Design, IOT Conceptual architecture, IOT protocols, Levels of IOT, IOT networking Protocols, Networking standards and technologies in IOT.

Text Book1: Ch 3, 3.1-3.8

Module-3

Introduction of 5G networks in IoT, IoT Networking consideration and Challenges, Business case for the IoT, Network optimization for IoT devices, Transport Layer protocols, Network Layer Protocols, IoT communication Challenges, Application Protocols for IoT.

Text Book1: Ch 3, 3.9-3.17.

Module-4

Introduction, Evolution of IIOT, Advantages of IIOT, Drivers, Risk associated with IIOT, Businesses and Industries approach IIOT security, Applications of IIOT, Work flow of IIOT, Security considerations and challenges, IIOT: Use Cases.

Text Book1: Ch 4, 4.1-4.11

Module-5

Introduction, IIOT layered Architecture, three tier IIOT, Security in IIOT, Service based Frameworks, Solutions against Intrusions in IIOT, Machine learning based solutions, Deep Learning based solutions.

Text Book1: Ch 5, 5.1-5.9

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks

1. Dr. Vijendra Pratap Singh, Mr. Neeraj Kumar., "IoT Communication Protocols", ISBN: 978-81961690-9-1, Deccan International Academic Publishers,2023.

Reference Books

2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.

3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Weblinks and Video Lectures (e-Resources):

- https://books.google.co.in/books?id=PSe0EAAAQBAJ&printsec=frontcover&source=gbs_ge_summaryr&cad=0#v=onepage&q&f=false
- https://link.springer.com/book/10.1007/978-3-642-19157-2
- https://onlinecourses.nptel.ac.in/noc19_cs65/preview
- https://archive.nptel.ac.in/courses/106/105/106105166/
- https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Skill Development Activities Suggested

- Demonstration of IoT protocols using any simulation tools.
- The students' team may of the size of 2 or 4. Students are expected to use any simulation tools to demonstrate some IoT protocols and then they have to prepare a report and then to be submitted to the concerned staff.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand fundamentals of IoT and Architecture.	L2
CO2	Illustrate the different layers of IoT protocols.	L3
CO3	Explore the importance of Industrial IoT.	L4
C04	Demonstrate Use cases of IIoT applications.	L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		**1**						**2**
CO2			**2**					
CO3				**3**				
CO4			**2**	**3**				

Semester- III

Software and Programming in IOT			
Course Code	**MMCG311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the Fundamentals of IoT Programming with Python
- Develop RESTful API and Web Socket-based IoT Applications
- Implement MQTT-based IoT Communication
- Integrate IoT with Visualization and Automation Platforms
- Explore the Synergies of IoT with Emerging Technologies

Module-1

Programming with Python - Setting Up your Development Environment, Understanding your Python installation, Getting Started with Python and IoT, Creating a breadboard prototype circuit, Reading an electronic schematic diagram, Exploring two ways to flash an LED in Python, Exploring two ways to integrate a push button in Python, Creating your first IoT program.

Module-2

Networking with RESTful APIs and Web Sockets Using Flask, Introducing the Flask microservices framework, Creating a RESTful API service with Flask-RESTful, Creating a Web Socket service with Flask-SocketIO, Adding a Web Socket client web page, Comparing the RESTful API and Web Socket servers.

Module-3

Networking with MQTT, Python, and the Mosquitto MQTT Broker, Installing the Mosquitto MQTT broker, Learning MQTT by example, Introducing the Python Paho-MQTT client library, Controlling an LED with Python and MQTT, Building a web-based MQTT client.

Module-4

IoT Visualization and Automation Platforms-Triggering an IFTTT Applet from your Raspberry Pi, Actioning your Raspberry Pi from an IFTTT Applet, Visualizing data with the ThingSpeak platform, Other IoT and automation platforms for further exploration.

Module-5

Exploring Synergies with Emerging Technologies, Benefits of combining IoT and blockchain, Benefits of combining IoT and generative AI, Benefits of combining IoT and LLM, Benefits of combining IoT and AI/ML, Benefits of combining IoT with immersive Technologies, Benefits of combining IoT with 3D and 4D printing, Benefits of combining IoT with 5G and 6G, Benefits of combining IoT and cloud.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately

Suggested Learning Resources: Textbooks:

1. Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, WebSockets, and Python 3, Gary Smart, Publisher(s): Packt Publishing.
2. Architectural Patterns and Techniques for Developing IoT Solutions, Jasbir Singh Dhaliwal, Packt Publishing
3. Raspberry Pi Cookbook, Simon Monk, Publisher(s): O'Reilly Media, Inc.

Reference Books:

4. Programming the Internet of Things, by Andy King, Publisher O'Reilly Media, Inc.
5. Internet of Things: Architecture and Design Principles, Raj Kamal, McGraw Hill Education (India) Private Limited

Web links and Video Lectures (e-Resources):

Web links:

- Flask Basics – https://flask.palletsprojects.com/en/latest/
- Building RESTful APIs with Flask-RESTful – https://flask-restful.readthedocs.io/en/latest/
- Flask-SocketIO for Real-time WebSockets – https://flask-socketio.readthedocs.io/en/latest/
- Triggering IFTTT with Raspberry Pi – https://ifttt.com/
- Learning MQTT Protocol – https://www.hivemq.com/mqtt-essentials

Video Lectures:

https://youtu.be/E2ZBZb_WKMw
https://youtu.be/t7vQF0ynF9g
https://youtu.be/38PkhZBaEE4
https://youtu.be/dPhr1YCQTU4
https://youtu.be/gRRcFdmtjOM
https://youtu.be/z3YMz-Gocmw

Skill Development Activities Suggested

- The students with the help of the course teacher can take up technical activities which will enhance their skill or the students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/testing/projects, and for creative and innovative methods to solve the identified problem. The prepared report shall be evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate basic IOT programming in Python.	L1,L2
CO2	Develop practical applications with RESTful API, Web Sockets, MQTT, IFTTT etc.	L3,L2
CO3	Apply IoT techniques to solve real world problems.	L3,L5

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**							
CO2			**2**					
CO3		**2**			**3**			

Semester- III

Ethical Hacking			
Course Code	**MMCH311A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To develop a comprehensive understanding of ethical hacking principles, methodologies, and tools, and recognize the significance of ethical and legal considerations in conducting security assessments.
- To acquire hands-on proficiency in executing penetration tests, vulnerability assessments ,and Ethical hacking techniques across various system components, networks, and applications.
- To demonstratetheabilitytoidentify,assess,andprioritizevulnerabilitiesindiversecomputing environmentsusingbothmanualandautomatedmethods,andeffectivelycommunicatethese findings to stakeholders.
- To develop a strategic mindset towards cyber security by acquiring knowledge of common attack Vectors,learningtosimulatereal-worldattacks,andimplementingpreventivemeasuresto secure systems,Networks and web applications.

Module-1

Introduction to Ethical Hacking

Introduction to ethical hacking and its importance, Legal and ethical considerations in ethical hacking, Differentiating between black hat, white hat, and grey hat hacking, Basic cyber security concepts and terminology, Overview of penetration testing methodologies

Textbook:1 Chapter1 Textbook:2 Chapter1,2

Module-2

Foot printing and Information Gathering

Passive and active information gathering techniques, Who is lookup, DNS enumeration, and social engineering, Tools and methodologies for foot printing, Google hacking and OSINT (Open Source Intelligence) techniques

Textbook:1 Chapter3

Module-3

Scanning and Enumeration: Port scanning techniques: SYN,TCP,UDP scans; Service enumeration and version detection; NetBIOS, SNMP, and SMTP enumeration; Vulnerability scanning and assessment

Textbook:1 Chapter 3,4, 5

Module-4

System Hacking and Exploitation

Passwordcrackingtechniquesandtools;Privilegeescalationandmaintainingaccess;Malware types andcountermeasures;Exploitingcommonvulnerabilities(e.g.,bufferoverflow,SQLinjection)

Textbook:1 Chapter 7, 9, 10

Module-5

Web Application and Network Security

Common web vulnerabilities: SQL injection, XSS, CSRF; Web application penetration testing methodology; Network sniffing and spoofing; Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS)

Textbook:1 Chapter6, 12 Textbook:1 Chapter1

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each modul

Suggested Learning Resources:Books

Text Books	
1	RafayBaloch,EthicalHackingandPenetrationTestingGuide,CRCPress,2015,ISBN978-1-4822-3161-8(Paperback)
2	HarperAllen,GrayHatHacking:TheEthicalHackersHandBook,3rdEdition,McGrawHill,2011.
3	JayBeale,AndrewR.Baker,JoelEsler,SnortIntrusionDetectionandPreventionToolkit,Syngress Publishing,Inc,2007,ISBN-13:978-1-59749-099-3
Reference Books	
1	WilliamStallings,NetworkSecurityEssentials:ApplicationsandStandards,PearsonEducation Limited2017,ISBN13:978-1-292-15485-5
2	PatrickEngebretson,TheBasicsofHackingandPenetrationTesting,SyngressPublishing,2013, ISBN978-0-12-411644-3

E- Resources (NPTEL/ SWAYAM. Any Other)-mention links

Nmap-Official Documentation :https://nmap.org/book/
National Vulnerability Database(NVD):https://nvd.nist.gov/

Course Outcomes(COs)

At the end of the course, the student will be able to		**Learning Level**
CO1	**Explain** the core concepts, principles and legal Considerations of ethical hacking.	L2
CO2	**Make us of** different tools and techniques for information gathering, scanning and enumeration	L3
CO3	**Apply** tools and techniques for exploiting vulnerabilities, Network sniffing, web application hacking, system hacking, Escalating privileges, etc.	L3
CO4	**Analyze** the results of IDS/IPS, ethical hacking and penetration testing tasks	L4

Mapping of COS and POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	1					2		
CO2	2				2	3		
CO3	3				2	3		
CO4	3				3	2	3	

Semester-III

Cyber Security			
Course Code	**MMCH311B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To learn cybercrime and cyber law.
- To understand the cyber-attacks and tools for mitigating them.
- To understand information gathering.
- To learn how to detect a cyber-attack.
- To learn how to prevent a cyber-attack.

Module-1

INTRODUCTION Cyber Security – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment.

Module-2

ATTACKS AND COUNTER MEASURES OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Counter measures.

Module-3

RECONNAISSANCE Harvester – Who is – Netcraft – Host – Extracting Information from DNS – Extracting Information from E-mail Servers – Social Engineering Reconnaissance; Scanning – Port Scanning – Network Scanning and Vulnerability Scanning – Scanning Methodology – Ping Sweer Techniques – Nmap Command Switches.

Module-4

INTRUSION DETECTION Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots – Example System Snort.

Module-5

INTRUSION PREVENTION Firewalls and Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls – Firewall Basing – Firewall Location and Configurations –Intrusion Prevention Systems – Example Unified Threat Management Products.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

TEXT BOOKS:

1. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", Elsevier, 2011. (Unit-3)
2. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", Third Edition, Pearson Education, 2015. (Unit-4 & 5)
3. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021. (Unit-1 &2)

REFERENCE BOOKS

1. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning Publishers, 2013.
2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2011.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the basics of cyber security, cybercrime and cyber law	
CO2	Classify various types of attacks and learn the tools to launch the attacks	
CO3	Apply various tools to perform information gathering	
CO4	Apply intrusion techniques to detect intrusion	
CO5	Apply intrusion prevention techniques to prevent intrusion	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		1						
CO2		2		3				
CO3	2	2			3			
CO4	2	2			3	3		
CO5		1		2			3	

Semester- III

Cryptography and Network Security			
Course Code	**MMCH311C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To make the student learn different encryption techniques along with hash functions, MAC, digital signatures and their use in various protocols for network security and system security.

Module-1

INTRODUCTION: Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. CLASSICAL ENCRYPTION TECHNIQUES: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography.

Module-2

BLOCK CIPHERS AND THE DATA ENCRYPTION STANDARD: Block Cipher Principles, The Data Encryption Standard (DES), A DES Example, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles. BLOCK CIPHER OPERATION: Multiple Encryption and Triple DES, Electronic Codebook Mode, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode. STREAM CIPHERS : Stream ciphers,RC4 Ciphers, RC4.

Module-3

NUMBER THEORY-: Divisibility and the Division Algorithm, The Euclidean Algorithm, Modular Arithmetic, Prime Numbers, Fermat‟s and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, and Discrete Logarithms. PUBLIC-KEY CRYPTOGRAPHY, RSA AND OTHER PUBLIC-KEY CRYPTOSYSTEMS: Principles of Public-Key Cryptosystems, The RSA Algorithm, DiffieHellman Key Exchange, ElGamal Cryptosystem.

Module-4

CRYPTOGRAPHIC HASH FUNCTIONS: Applications of Cryptographic Hash Function, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA). MESSAGE AUTHENTICATION CODES: Message Authentication Requirements, Message Authentication Functions, Message Authentication Codes, Security of MACs, MACs Based on Hash Functions (HMAC).

Module-5

DIGITAL SIGNATURES- Digital Signatures, ElGamal Digital Signature Scheme, Schnorr Digital Signature Scheme, Digital Signature Standard (DSS). KEY MANAGEMENT AND ISTRIBUTION: Symmetric Key Distribution Using Symmetric Encryption, Symmetric Key Distribution Using Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Public Key Infrastructure.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. William Stallings: Cryptography and Network Security- Principles And Practice, 5th Edition, Pearson/PHI, 2011.

Reference books:

1. William Stallings, "Network Security Essentials (Applications and Standards)", 4th Edition, Pearson Education. , 2012
2. Charlie Kaufman, Radia Perlman and Mike Speciner: "Network Security – Private Communication in a Public World", 2nd Edition, Pearson/PHI, 2002.
3. Eric Maiwald: "Fundamentals of Network Security", 1st Edition, Dreamtech Press, 2003.
4. Whitman: "Principles of Information Security", 3rd Edition, Thomson, 2009.
5. Robert Bragg, Mark Rhodes: "Network Security: The complete reference", 1st Edition, TMH, 2004.
6. Buchmann: "Introduction to Cryptography", 2nd Edition, Springer, 2004.

Web links and Video Lectures (e-Resources):

- http://www.nptel.iitm.ac.in/courses/106105031/.
- https://www.youtube.com/playlist?list=PLBlnK6fEyqRgJU3EsOYDTW7m6SUmW6kII&utm_source=chatgpt.com
- https://www.youtube.com/playlist?list=PL71FE85723FD414D7
- https://www.youtube.com/playlist?list=PL_LGG4Jw4MdFPrMZg-otwrRPPAoXT-vgO
- https://onlinecourses.nptel.ac.in/noc20_cs21/preview?utm_source=chatgpt.com

Skill Development Activities Suggested

- Implement Caesar Cipher and Vigenère Cipher using Python.
- Implement DES and Triple DES encryption using a programming language.
- Write code for Euclidean algorithm, Modular inverse, and Chinese Remainder Theorem.
- Case study: Discuss a real-world cyberattack prevented using public-key crypto.
- Build a simple login system with hashed passwords.
- Implement a digital signature using ElGamal or RSA.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyze and design classical encryption techniques and block ciphers	L2
CO2	Understand and analyze data encryption standard.	L2
CO3	Understand and analyze public-key cryptography, RSA and other public-key cryptosystems	L2
CO4	Understand key management and distribution schemes and design User Authentication, such as Diffie-Hellman Key Exchange, ElGamal Cryptosystem, etc	L2
CO5	Apply intrusion prevention techniques to prevent intrusion	L2

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		1			2			
CO2	2				1			
CO3		2				3		
CO4	1		2					
CO5		1		2				3

Semester- III

Blockchain Technologies			
Course Code	**MMCH311D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Demonstrate the basics of Block chain concepts using modern tools/technologies.
- Illustrate the role of block chain applications in different domains including cyber security.
- EvaluatetheusageofBlockchainimplementation/featuresforthegivenproblem.
- Exemplify the usage of bit coins and its impact on the economy.
- Analyzetheapplicationofspecificblockchainarchitectureforagivenproblem

Module-1

Introduction to Blockchain,How Blockchain works, Blockchain vs Bitcoin, Practical applications, public and Private key basics, pros and cons of Blockchain,Myths about Bitcoin.

Module-2

Block chain: Architecture, versions, variants, use cases, Life use cases of block chain, Block chain vs shared Database,Introduction to crypto currencies, Types, Applications.Ciphers, RC4.

Module-3

Concept of Double Spending, Hashing, Mining, Proof of work. Introduction to Merkel tree, Privacy ,payment verification , Resolving Conflicts , Creation of Blocks

Module-4

Introduction to Bitcoin, key concepts of Bitcoin, Merits and De Merits Fork and Segwits, Sending and Receiving bitcoins, choosing bitcoin wallet, Converting Bitcoins to Fiat Currency.

Module-5

Introduction to Ethereum, Advantages and Disadvantages, Ethereum vs Bitcoin, Introduction to Smart contracts, usage, application, working principle, Law and Regulations. Case Study.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

- Beginning Block chain: A Beginner's Guide to Building Blockchain Solutions by ArshdeepBikramaditya Signal,Gautam Dhameja (Priyansu Sekhar Panda., A Press.) 2018
- Block chain Applications: A Hands-On Approach by Bahga, Vijay Madisetti ,2017
- Block chain by Melanie Swan, O Reilly 2015

Reference Books

- Bitcoin and Cryptocurrency Technologies by Aravind Narayan. Joseph Bonneau, princton
- Bitcoin and Blockchain Basics: A non-technical introduction for beginners by Arthu.T Books.

Web links and Video Lectures (e-Resources):

- https://youtu.be/mzPoUjQC4WU

Skill Development Activities Suggested

- Create a comparative chart: Blockchain vs Bitcoin vs Traditional Databases.
- Develop a flowchart showing how a cryptocurrency transaction flows through a blockchain.
- Simulate the proof-of-work process using hash functions (SHA256) in Python.
- Create a bitcoin wallet using a mobile app or online simulator (no real money involved).

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Bloom s Level
CO1	Demonstrate the basics of Block chain concepts using modern tools/technologies.	L2
CO2	Analyze the role of block chain applications in different domains including cyber security.	L3
CO3	Evaluate the usage of Block chain implementation/features for the given problem.	L2
CO4	Exemplify the usage of bitcoins and its impact on the economy	L2
CO5	Analyze the application of specific block chain architecture for a given problem	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		1			1			
CO2	1		2					
CO3		2				2		
CO4				2	3			
CO5			3			3		

Semester- III

Database & Web Application Security			
Course Code	**MMCH311E**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the fundamentals of database security concepts, Identify key security threats and vulnerabilities.
- To examine security mechanisms and best practices for database protection Design and implement security solutions.
- To identify and analyze vulnerabilities in web applications and databases.
- To design secure web applications
- To evaluate tools and techniques for detecting and mitigating security breaches

Module-1
SUPPORTING TECHNOLOGIES FOR DATABASE AND APPLICATIONS SECURITY: Data Management Technologies, Information Security, Information Management Technologies.
Module-2
DISCRETIONARY SECURITY FOR DATABASE SYSTEMS: Security Policies, Policy Enforcement and Related Issues.
Module-3
MANDATORY SECURITY FOR DATABASE SYSTEMS: Historical Developments, Design Principles.
Module-4
MULTILEVEL SECURE RELATIONAL DATABASE SYSTEMS: Multilevel Relational Data Models, Security Impact on Database Functions, Prototypes and Products.
Module-5
THE INFERENCE PROBLEM: A Perspective of the Inference Problem, Security-Constraint Processing for Inference Control, Conceptual Structures for Inference Control

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

TEXT BOOKS:

1. BhavaniThuraisingham, "Database and Applications Security", Integrating Information Security and Data Management, Auerbach Publications, 2005.

REFERENCES:

1. Michael Gertz and SushilJajodia, "Handbook of Database Security— Applications andTrends", Springer, 2008.
2. Bryan and Vincent, "Web Application Security, A Beginners Guide", McGraw-Hill, 2011
3. Alfred Basta, Melissa Zgola, "Database Security", Course Technology, 2012.

Web links and Video Lectures (e-Resources):

- https://www.scribd.com/document/450222788/1-2012-Web-Application-Security-a-Beginer-Guide

Skill Development Activities Suggested

- Use OWASP Juice Shop or DVWA (Damn Vulnerable Web Application) to identify and exploit vulnerabilities like SQL Injection, XSS, CSRF.
- Students rewrite vulnerable code snippets using secure practices (input validation, sanitization, etc.).

Course outcome (Course Skill Set)
At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Describe core concepts of database and web application security, including data confidentiality, integrity, and access control.	L1
CO2	Identify and explain common vulnerabilities in web applications and databases.	L2
CO3	Apply appropriate security mechanisms (encryption, authentication, access control) to protect databases and web applications.	L2
CO4	Develop secure web applications using industry best practices and secure coding techniques.	L3
CO5	Use tools and techniques to analyze, test, and mitigate real-world security threats and attacks.	L3

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**1**							
CO2		**2**						**3**
CO3						**3**		
CO4				**2**				
CO5			**3**					

Semester- III

Mobile and Wireless Security			
Course Code	**MMCH311F**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand mobile and wireless communication fundamentals.
- Identify key security threats and vulnerabilities.
- Analyze security mechanisms in mobile and wireless systems.
- Design and implement security solutions
- Explore emerging trends and research areas

Module-1

Security Issues in Mobile Communication: Mobile Communication History, Security – Wired Vs Wireless, Security Issues in Wireless and Mobile Communications, Security Requirements in Wireless and Mobile Communications, Security for Mobile Applications, Advantages and Disadvantages of Application – level Security.

Module-2

Security of Device, Network, and Server Levels: Mobile Devices Security Requirements, Mobile Wireless network level Security, Server Level Security. Application-Level Security in Wireless Networks: Application of WLANs, Wireless Threats, Some Vulnerabilities and Attach Methods over WLANs, Security for 1G Wi-Fi Applications, Security for 2G Wi-Fi Applications, Recent Security Schemes for Wi-Fi Applications

Module-3

Application-Level Security in Cellular Networks: Generations of Cellular Networks, Security Issues and attacks in cellular networks, GSM Security for applications, GPRS Security for applications, UMTS security for applications, 3G security for applications, Some of Security and authentication Solutions.

Module-4

Application-Level Security in MANETs: MANETs, Some applications of MANETs, MANET Features, Security Challenges in MANETs, Security Attacks on MANETs, External Threats for MANET applications, Internal threats for MANET Applications, Some of the Security Solutions. Ubiquitous Computing, Need for Novel Security Schemes for UC, Security Challenges for UC, and Security Attacks on UC networks, Some of the security solutions for UC.

Module-5

Security for Mobile Commerce Application: M-commerce Initiatives, Security Challenges in Mobile E-commerce, Types of Attacks on Mobile E-commerce, A Secure M-commerce Model Based on Wireless Local Area Network, Some of M-Commerce Security Solutions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

TEXT BOOKS:

1. Pallapa Venkataram, Satish Babu: "Wireless and Mobile Network Security", 1st Edition, Tata McGraw Hill,2010.
2. Frank Adelstein, K.S.Gupta : "Fundamentals of Mobile and Pervasive Computing", 1st Edition, Tata McGraw Hill 2005**.**

REFERENCES:

1. Randall k. Nichols, Panos C. Lekkas: "Wireless Security Models, Threats and Solutions", 1st Edition, Tata McGraw Hill, 2006.
2. Bruce Potter and Bob Fleck: "802.11 Security," 1st Edition, SPD O'REILLY 2005.
3. James Kempf: "Guide to Wireless Network Security, Springer. Wireless Internet Security – Architecture and Protocols", 1st Edition, Cambridge University Press, 2008

Web links and Video Lectures (e-Resources):

- https://dokumen.pub/qdownload/wireless-and-mobile-network-security-9780070700246-0070700249.html

Skill Development Activities Suggested

- Programming Assignment-1: Implementation of important concepts of data manipulation using NumPy and Pandas (Python
- Programming Assignment-2: Implementation of simple Machine Learning models with Visualization using Python (MatPlotlib, Scikitlearn)

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Familiarize with the issues and technologies involved in designing a wireless and mobile system that is robust against various attacks.	L1
CO2	Gain knowledge and understanding of the various ways in which wireless networks can be attacked and trade-offs in protecting networks.	L2
CO3	Have a broad knowledge of the state-of-the-art and open problems in wireless and mobile security, thus enhancing their potential to do research or pursue a career in this rapidly developing area.	L2
CO4	Learn various security issues involved in cloud computing.	L3
CO5	Learn various security issues related to GPRS and 3G.	L3

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1							
CO2		2						2
CO3			3					
CO4					3			
CO5			2			3		